



AGRICULTURAL RESEARCH INSTITUTE
PUSA

PHILOSOPHICAL
TRANSACTIONS,
GIVING SOME
ACCOUNT
OF THE
Present Undertakings, Studies, *and* Labours,
OF THE
INGENIOUS,
IN MANY
Considerable Parts of the WORLD.

VOL. LXI. For the Year 1771.
PART I.

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M.DCC.LXXII.

ADVERTISEMENT.

THE Committee appointed by the *Royal Society* to direct the publication of the *Philosophical Transactions*, take this opportunity to acquaint the Public, that it fully appears, as well from the council-books and journals of the Society, as from repeated declarations, which have been made in several former *Transactions*, that the printing of them was always, from time to time, the single act of the respective Secretaries, till the Forty-seventh Volume. And this information was thought the more necessary, not only as it has been the common opinion, that they were published by the authority, and under the direction, of the Society itself; but also, because several authors, both at home and abroad, have in their writings called them the *Transactions of the Royal Society*. Whereas in truth the Society, as a body, never did interest themselves any further in their publication, than by occasionally recommending the revival of them to some of their Secretaries, when, from the particular circumstances of their affairs, the *Transactions* had happened for any length of time to be intermitted. And this seems principally to have been done with a view to satisfy the Public, that their usual meetings were then continued for the improvement of knowledge, and benefit of mankind, the great ends of their first institution by the Royal Charters, and which they have ever since steadily pursued.

But the Society being of late years greatly enlarged, and their communications more numerous, it was thought adviseable, that a Committee of their Members should be appointed to reconsider the papers read before them, and select out of them such, as they

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should judge most proper for publication in the future *Transactions*; which was accordingly done upon the 26th of March 1752. And the grounds of their choice are, and will continue to be, the importance or singularity of the subjects, or the advantageous manner of treating them; without pretending to answer for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgment of their respective authors.

It is likewise necessary on this occasion to remark, that it is an established rule of the Society, to which they will always adhere, never to give their opinion, as a body, upon any subject, either of Nature or Art, that comes before them. And therefore the thanks, which are frequently proposed from the chair, to be given to the authors of such papers, as are read at their accustomed meetings, or to the persons through whose hands they receive them, are to be considered in no other light than as a matter of civility, in return for the respect shewn to the Society by those communications. The like also is to be said with regard to the several projects, inventions, and curiosities of various kinds, which are often exhibited to the Society; the authors whereof, or those who exhibit them, frequently take the liberty to report, and even to certify in the public news-papers, that they have met with the highest applause and approbation. And therefore it is hoped, that no regard will hereafter be paid to such reports, and public notices; which in some instances have been too lightly credited, to the dishonour of the Society.

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ROYAL SOCIETY

In the YEAR 1771;

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P H I L O S O P H I C A L T R A N S A C T I O N S.

I. *Remarks upon the Nature of the Soil of Naples, and it's Neighbourhood; in a Letter from the Honourable William Hamilton, His Majesty's Envoy Extraordinary at Naples, to Mathew Maty, M. D. Sec. R. S.*

S I R,

Naples, Oct. 16, 1770

Read Jan. 10. 17. 24.
1771.

ACCORDING to your desire, I lose no time in sending you such further remarks as I have been making with some diligence, for six years past, in the compass of twenty miles or more, round this capital. By accompanying these remarks with a map of the country I describe, and with the specimens of different matters that compose the most remarkable spots of it,

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I do not doubt but that I shall convince you, as I am myself convinced, that the whole circuit (so far as I have examined) within the boundaries marked in the map, is wholly and totally the production of subterraneous fires; and that most probably the sea formerly reached the mountains that lie behind Capua and Caserta, and are a continuation of the Appennines. If I may be allowed to compare small things with great, I imagine the subterraneous fires to have worked in this country under the bottom of the sea, as moles in a field, throwing up here and there a hillock, and that the matter thrown out of some of these hillocks formed into settled volcanos, filling up the space between one and the other; has composed this part of the continent, and many of the islands adjoining.

From the observations I have made upon mount Etna, Vesuvius, and its neighbourhood, I dare say, that, after a careful examination, most mountains that are, or have been volcanos, would be found to owe their existence to subterraneous fire; the direct reverse of what I find the commonly received opinion.

Nature, though varied, is certainly in general uniform in her operations; and I cannot conceive that two such considerable volcanos as Etna and Vesuvius should have been formed otherwise, than every other considerable volcano of the known world. I do not wonder that so little progress has been made in the improvement of natural history, and particularly in that branch of it which regards the theory of the earth; nature acts slowly, it is difficult to catch her in the fact. Those who have made this subject

subject their study have, without scruple, undertaken at once, to write the natural history of a whole province, or of an entire continent; not reflecting, that the longest life of man scarcely affords him time to give a perfect one of the smallest insect.

I am sensible of what I undertake in giving you, Sir, even a very imperfect account of the nature of the soil of a little more than twenty miles round Naples: yet I flatter myself that my remarks, such as they are, may be of some use to any one hereafter, who may have leisure and inclination to follow them up. The kingdom of the Two Sicilies offers certainly the fairest field for observations of this kind, of any in the whole world; here are volcanos existing in their full force, some on their decline, and others totally extinct.

To begin with some degree of order, which is really difficult in the variety of matter that occurs to my mind, I will first mention the basis on which I found all my conjectures. It is the nature of the soil that covers the antient towns of Herculaneum and Pompeii, and the interior and exterior form of the new mountain, near Puzzole, with the sort of materials of which it is composed. It cannot be denied that Herculaneum and Pompeii stood once above ground; though now, the former is in no part less than seventy feet, and in some parts one hundred and twelve feet, below the present surface of the earth; and the latter is buried ten or twelve feet deep, more or less. As we know from the very accurate account given by Pliny the younger, to Tacitus, and from the accounts of other contemporary authors, that these towns were buried by an eruption

of mount Vesuvius in the time of Titus; it must be allowed, that whatever matter lies between these cities and the present surface of the earth over them, must have been produced since the year 79 of the Christian æra, the date of that formidable eruption.

Pompeii, which is situated at a much greater distance from the volcano than Herculaneum, has felt the effects of a single eruption only; it is covered with white pumice stones mixed with fragments of lava and burnt matter, large and small; the pumice is very light, but I have found some of the fragments of lava and cinders there, weighing eight pounds. I have often wondered that such weighty bodies could have been carried to such a distance (for Pompeii cannot be less than five miles, in a strait line, from the mouth of Vesuvius). Every observation confirms the fall of this horrid shower over the unfortunate city of Pompeii, and that few of its inhabitants had dared to venture out of their houses; for in many of those which have been already cleared, skeletons have been found, some with gold rings, ear rings, and bracelets. I have been present at the discovery of several human skeletons myself; and under a vaulted arch, about two years ago, at Pompeii, I saw the bones of a man and a horse taken up, with the fragments of the horse's furniture, which had been ornamented with false gems set in bronze. The skulls of some of the skeletons found in the streets had been evidently fractured by the fall of the stones. His Sicilian majesty's excavations are confined to this spot at present; and the curious in antiquity may expect hereafter, from so rich a mine, ample matter for their dissertations: but I will confine myself

to

so such observations only as relate to my present subject.

Over the stratum of pumice and burnt matter that covers Pompeii, there is a stratum of good mould, of the thickness of about two feet and more in some parts, in which vines flourish, except in some particular spots of this vineyard, where they are subject to be blasted by a foul vapour or *mofete*, as it is called here, that rises from beneath the burnt matter. The abovementioned shower of pumice stones, according to my observations, extended beyond Castel-a-mare (near which spot the ancient town of Stabia also lies buried under them), and covered a tract of country not less than thirty miles in circumference. It was at Stabia that Pliny the elder lost his life, and this shower of pumice stones is well described in the younger Pliny's letter. Little of the matter that has issued from Vesuvius since that time, has reached these parts: but I must observe that the pavement of the streets of Pompeii is of lava; nay, under the foundation of the town, there is a deep stratum of lava and burnt matter. These circumstances, with many others that will be related hereafter, prove, beyond a doubt, that there have been eruptions of Vesuvius previous to that of the year 79, which is the first recorded by history.

The growth of soil by time is easily accounted for; and who, that has visited ruins of ancient edifices, has not often seen a flourishing shrub, in a good soil, upon the top of an old wall? I have remarked ~~many~~ such on the most considerable ruins at Rome and elsewhere. But from the soil which has grown over the ~~buried~~ pumice that covers Pompeii, I was enabled.

enabled to make a curious observation. Upon examining the cuts and hollow ways made by currents of water in the neighbourhood of Vesuvius and of other volcanos, I had remarked that there lay frequently a stratum of rich soil, of more or less depth, between the matter produced by the explosion of succeeding eruptions; and I was naturally led to think that such a stratum had grown in the same manner as the one abovementioned over the pumice of Pompeii. Where the stratum of good soil was thick, it was evident to me that many years had elapsed between one eruption and that which succeeded it. I do not pretend to say that a just estimate can be formed of the great age of volcanos from this observation, but some sort of calculation might be made; for instance, should an explosion of pumice cover again the spot under which Pompeii is buried, the stratum of rich soil abovementioned would certainly lie between two beds of pumice; and if a like accident had happened a thousand years ago, the stratum of rich soil would as certainly have wanted much of its present thickness, as the rotting of vegetables, manure, &c. is ever increasing a cultivated soil. Whenever I find then a succession of different strata of pumice and burnt matter like that which covers Pompeii, intermixed with strata of rich soil, of greater or less depth, I hope I may be allowed reasonably to conclude, that the whole has been the production of a long series of eruptions occasioned by subterraneous fire. By the size and weight of the pumice, and fragments of burnt erupted matter in these strata, it is easy to trace them up to their source, which I have done more than once in the neighbourhood

hood of Puzzole, where explosions have been frequent. The gradual decrease in the size and quantity of the erupted matter in the stratum above-mentioned, from Pompeii to Castle-a-Mare, is very visible: at Pompeii, as I said before, I have found them of eight pounds weight, when at Castle-a-Mare the largest do not weigh an ounce.

The matter which covers the ancient town of Herculaneum is not the produce of one eruption only; for there are evident marks that the matter of six eruptions has taken its course over that which lies immediately above the town, and was the cause of its destruction. These strata are either of lava or burnt matter, with veins of good soil between them. The stratum of erupted matter that immediately covers the town, and with which the theatre and most of the houses were filled, is not of that foul vitrified matter, called lava, but of a sort of soft stone, composed of pumice, ashes, and burnt matter. It is exactly of the same nature with what is called here the Naples stone; the Italians distinguish it by the name of *tufa*, and it is in general use for building. Its colour is usually that of our free stone, but sometimes tinged with grey, green, and yellow; and the pumice stones, with which it ever abounds, are sometimes large and sometimes small: it varies likewise in its degree of solidity.

The chief article in the composition of this *tufa* seems to me to be, that fine burnt material, which is called *puzzolane*, whose binding quality and utility by way of cement are mentioned by Vitruvius, and which is to be met with only in countries that have been subject to subterraneous fires. It is, I believe, a sort of lime prepared

pared by nature. This, mixed with water, great or small pumice stones, fragments of lava, and burnt matter, may naturally be supposed to harden into a stone of this kind; and, as water frequently attends eruptions of fire, as will be seen in the accounts I shall give of the formation of the new mountain near Puzzole, I am convinced the first matter that issued from Vesuvius, and covered Herculaneum, was in the state of liquid mud. A circumstance strongly favouring my opinion is, that, about two years ago, I saw the head of an antique statue dug out of this matter within the theatre of Herculaneum; the impression of its face remains to this day in the *tufa*, and might serve as a mould for a cast in plaister of Paris, being as perfect as any mould I ever saw. As much may be inferred from the exact resemblance of this matter, or *tufa*, which immediately covers Herculaneum, to all the *tufa* of which the high grounds of Naples and its neighbourhood are composed; I detached a piece of it sticking to, and incorporated with, the painted stucco of the inside of the theatre of Herculaneum, and shall send it for your inspection*. It is very different, as you will see, from the vitrified matter called lava, by which it has been generally thought that Herculaneum was destroyed. The village of Refina and some villas stand at present above this unfortunate town.

To account for the very great difference of the matters that cover Herculaneum and Pompeii, I have often thought that in the eruption of 79 the moun-

* This piece is now in the Museum of the Royal Society, together with many other specimens, mentioned in this and in the following letter. M. M.

tain must have been open in more than one place. A passage in Pliny's letter to Tacitus seems to say as much, "*Interim e Vesuvio monte pluribus locis latissimæ flammæ, atque incendia relucebant, quorum fulgor et claritas tenebras noctis pellebat :*" so that very probably the matter that covers Pompeii proceeded from a mouth, or crater, much nearer to it than is the great mouth of the volcano, from whence came the matter that covers Herculaneum. This matter might nevertheless be said to have proceeded from Vesuvius, just as the eruption in the year 1760, which was quite independent of the great crater (being four miles from it), is properly called an eruption of Vesuvius.

In the beginning of eruptions, volcanos frequently throw up water mixed with the ashes. Vesuvius did so in the eruption of 1631, according to the testimony of many contemporary writers. The same circumstance happened in 1669 according to the account of Ignazzio Sorrentino, who, by his History of Mount Vesuvius printed at Naples in 1734, has shewn himself to have been a very accurate observer of the phænomena of the volcano, for many years that he lived at Torre del Greco, situated at the foot of it. At the beginning of the formation of the new mountain, near Puzzole, water was mixed with the ashes thrown up, as will be seen in two very curious and particular accounts of the formation of that mountain, which I shall have the pleasure of communicating to you presently; and in 1755 Etna threw up a quantity of water in the beginning of an eruption, as is mentioned in the letter I sent you last

year upon the subject of that magnificent volcano*. Ulloa likewise mentions this circumstance of water attending the eruptions of volcanos in America. Whenever therefore I find a *tufa* composed exactly like that which immediately covers Herculaneum, and undoubtedly proceeded from Vesuvius, I conclude such a *tufa* to have been produced by water mixing with the erupted matter at the time of an explosion occasioned by subterraneous fire; and this observation, I believe, will be of more use than any other, in pointing out those parts of the present *terra firma*, that have been formed by explosion. I am convinced it has often happened that subterraneous fires and exhalations, after having been pent up and confined for some time, and been the cause of earthquakes, have forced their passage, and in venting, themselves formed mountains of the matter that confined them, as you will see was the case near Puzzole in the year 1538, and by evident signs has been so before, in many parts of the neighbourhood of Puzzole; without creating a regular volcano. The materials of such mountains will have but little appearance of having been produced by fire, to any one unaccustomed to make observations upon the different nature of volcanos.

If it were allowed to make a comparison between the earth and a human body, one might consider a country replete with combustibles occasioning explosions (which is surely the case here) to be like a body full of humours. When these humours concentrate in one part, and form a great tumour out of which they are discharged freely, the body is less

* Phil. Transact. Vol. LX. p. 11.

agitated; but when by any accident the humours are checked, and do not find a free passage through their usual channel, the body is agitated, and tumours appear in other parts of that body, but soon after the humours return again to their former channel. In a similar manner one may conceive Vesuvius to be the present great channel, through which nature discharges some of the foul humours of the earth; when these humours are checked by any accident or stoppage in this channel for any considerable time, earthquakes will be frequent in its neighbourhood, and explosions may be apprehended even at some distance from it. This was the case in the year 1538, Vesuvius having been quiet for near 400 years. There was no eruption from its great crater from the year 1139 to the great eruption of 1631; and the top of the mountain began to lose all signs of fire. As it is not foreign to my purpose, and will serve to shew how greatly they are mistaken, who place the seat of the fire in the centre or towards the top of a volcano, I will give you a curious description of the state of the crater of Vesuvius, after having been free from eruptions 492 years, as related by Bracini, who descended into it not long before the eruption of 1631: "The crater was five miles in circumference, and about a thousand paces deep; its sides were covered with brush wood, and at the bottom there was a plain on which cattle grazed. In the woody parts, bears frequently harboured; in the midst of the plain, within the crater, was a narrow passage, through which, by a winding path, you could descend about a mile amongst rocks and stones, till you came to another more spacious plain

“plain covered with ashes: in this plain were three
 “little pools, placed in a triangular form, one to-
 “wards the East, of hot water, corrosive and bitter
 “beyond measure; another towards the West, of
 “water saltier than that of the sea; the third of hot
 “water, that had no particular taste.”

The great increase of the cone of Vesuvius, from that time to this, naturally induces one to conclude, that the whole of the cone was raised in the like manner, and that the part of Vesuvius, called Somma, which is now considered as a distinct mountain from it, was composed in the same manner. This may plainly be perceived by examining its interior and exterior form, and the strata of lava and burnt matter of which it is composed. The ancients, in describing Vesuvius, never mention two mountains. Strabo, Dio, Vitruvius, all agree, that Vesuvius, in their time, showed signs of having formerly erupted, and the first compares the crater on its top to an amphitheatre. The mountain now called Somma was, I believe, that which the ancients called Vesuvius; its outside form is conical, its inside, instead of an amphitheatre, is now like a great theatre. I suppose the eruption in Pliny's time to have thrown down that part of the cone next the sea, which would naturally have left it in its present state, and that the conical mountain, now existing Vesuvius, has been raised by the succeeding eruptions: all my observations confirm this opinion. I have seen ancient lavas in the plain on the other side of Somma, which could never have proceeded from the present Vesuvius. Scrao, a celebrated physician now living at Naples, in the introduction of his account of the eruption of Vesuvius

vius in 1737 (in which account many of the phenomena of the volcano are recorded and very well accounted for) says, that at the convent of Dominican Fryars, called the Madona del Arco, some years ago, in sinking a well, at a hundred feet depth, a lava was discovered, and soon after another, so that in less than three hundred feet depth, the lavas of four eruptions were found. From the situation of this convent it is clear beyond a doubt, that these lavas proceeded from the mountain called Somma, as they are quite out of the reach of the existing volcano.

From these circumstances, and from repeated observations I have made in the neighbourhood of Vesuvius, I am sure that no virgin soil is to be found there, and that all is composed of different strata of erupted matter, even to a great depth below the level of the sea. In short, I have not any doubt in my own mind, but that this volcano took its rise from the bottom of the sea; and as the whole plain between Vesuvius and the mountains behind Caserta, which is the best part of the Campagna Felice, is (under its good soil) composed of burnt matter, I imagine the sea to have washed the feet of those mountains, until the subterraneous fires began to operate, at a period certainly of a most remote antiquity.

The soil of the Campagna Felice is very fertile; I saw the earth opened in many places last year in the midst of that plain, when they were seeking for materials to mend the road from Naples to Caserta. The stratum of good soil was in general four or five feet thick; under which was a deep stratum of cinders, pumice, fragments of lava and such burnt matter as abounds near Vesuvius and all volcanoes.

The

The mountains at the back of Caserta are mostly of a sort of lime-stone, and very different from those formed by fire; though Signior Van Vitelli, the celebrated architect, has assured me, that in the cutting of the famous aqueduct of Caserta through these mountains, he met with some soils, that had been evidently formed by subterraneous fires. The high grounds which extend from Castel-a-Mare to the point of Minerva towards the island of Caprea, and from the promontory that divides the bay of Naples from that of Salerno, are of lime stone. The plain of Sorrento, that is bounded by these high grounds, beginning at the village of Vico, and ending at that of Massa, is wholly composed of the same sort of *tufa* as that about Naples, except that the cinder or pumice stones intermixed in it are larger than in the Naples *tufa*. I conceive then that there has been an explosion in this spot from the bottom of the sea. This plain, as I have remarked to be the case with all soils produced by subterraneous fire, is extremely fertile; whilst the ground about it, being of another nature, is not so. The island of Caprea does not shew any signs of having been formed by subterraneous fire, but is of the same nature as the high grounds last mentioned, from which it has been probably detached by earthquakes, or the violence of the waves. Ruvigliano, an island, or rather a rock in the bay of Castel-a-Mare, is likewise of lime stone, and seems to have belonged to the original mountains in its neighbourhood; in some of these mountains there are also petrified fish and fossil shells, which I never have found in the mountains, which I suppose to have been formed by explosion.

You

You have now, Sir, before you the nature of the soil, from Caprea to Naples. The soil on which this great metropolis stands has been evidently produced by explosions, some of which seem to have been upon the very spot on which this city is built; all the high grounds round Naples, Paufilipo, Puzzole, Baïa, Misenum, the islands of Procita and Ischia, all appear to have been raised by explosion. You can trace still in many of these heights the conical shape that was naturally given them at first, and even the craters out of which the matter issued, though to be sure others of these heights have suffered such changes by the hand of time, that you can only conjecture that they were raised in the like manner, by their composition being exactly the same as that of those mountains, which still retain their conical form and craters entire. A *tufa*, exactly resembling the specimen I took from the inside of the theatre of Herculaneum, layers of pumice intermixed with layers of good soil, just like those over Pompeii, and lavas like those of Vesuvius, compose the whole soil of the country that remains to be described.

The famous grotto anciently cut through the mountain of Paufilipo, to make a road from Naples to Puzzole, gives you an opportunity of seeing that the whole of that mountain is *tufa*. The first evident crater you meet with, after you have passed the grotto of Paufilipo, is now the lake of Agnano; a small remain of the subterraneous fire (which must probably have made the basin for the lake, and raised the high grounds which form a sort of amphitheatre round it) serves to heat rooms, which the Neapolitans make great use of in summer, for carrying off
diverse

diverse disorders, by a strong perspiration. This place is called the Sudatorio di San Germano; near the present bagnios, which are but poor little hovels, there are the ruins of a magnificent ancient bath. About an hundred paces from hence is the Grotto del Cane; I shall only mention, as a further proof of the probability that the lake of Agnano was a volcano, that vapours of a pernicious quality, as that in the Grotto del Cane, are frequently met with in the neighbourhood of Etna and Vesuvius, particularly at the time of, before, and after, great eruptions. The noxious vapour having continued in the same force constantly so many ages, as it has done in the Grotto del Cane (for Pliny mentions this Grotto), is indeed a circumstance in which it differs from the vapours near Vesuvius and Etna, which are not constant; the cone forming the outside of this supposed volcano is still perfect in many parts.

Opposite to the Grotto del Cane, and immediately joining to the lake, rises the mountain called Astruni, which, having, as I imagine, been thrown up by an explosion of a much later date, retains the conical shape and every symptom of a volcano in much greater perfection than that I have been describing. The crater of Astruni is surrounded with a wall to confine boars and deer (this volcano having been for many years converted to a royal chace). It may be about six miles or more in circumference; in the plain at the bottom of the crater are two lakes, and in some books there is mention made of a hot spring, which I never have been able to find. There are many huge rocks of lava within the crater of Astruni, and some I have met with also in that of Agnano; the

the cones of both these supposed volcanos are composed of *tufa* and strata of loose pumice, fragments of lava and other burnt matter, exactly resembling the strata of Vesuvius. Bartholomeus Fatius, who wrote of the actions of king Alphonso the first (before the new mountain had been formed near Puzzole), conjectured that Astruni had been a volcano. These are his words: *Locus Neapoli quatuor millia passuum proximus, quem vulgo Lustrones vocant, nos unum e Phlegreeis Campis ab ardore nuncupandum putamus.* There is no entrance into the crater of either Astruni or Agnano, except one, evidently made by art, and they both exactly correspond with Strabo's description of avenues; the same may be said of the Solfaterra and the Monte Gauro, or Barbaro as it is sometimes called, which I shall describe presently.

Near Astruni and towards the sea rises the Solfaterra, which not only retains its cone and crater, but much of its former heat. In the plain within the crater, smoke issues from many parts, as also from its sides; here, by means of stones and tiles heaped over the crevices, through which the smoke passes, they collect in an awkward manner what they call *sale armoniaco*; and from the sand of the plain they extract sulphur and alum. This spot well attended to might certainly produce a good revenue, whereas I doubt if they have hitherto ever cleared 200 *l.* a year by it. The hollow sound produced by throwing a heavy stone on the plain of the crater of the Solfaterra seems to indicate, that it is supported by a sort of arched natural vault; and one is induced to think that there is a pool of water beneath this vault (which boils by the heat of a subterraneous fire still deeper)

by the very moist stream that issues from the cracks in the plain of the Solfaterra, which, like that of boiling water, runs off a sword or knife, presented to it, in great drops. On the outside, and at the foot of the cone of the Solfaterra, towards the lake of Agnano, water rushes out of the rocks, so hot, as to raise the quicksilver in Fahrenheit's thermometer to the degree of boiling water a fact of which I was myself an eye-witness. This place, well worthy the observation of the curious, has been taken little notice of; it is called the *Pisciarelli*. The common people of Naples have great faith in the efficacy of this water, and make much use of it in all cutaneous disorders, as well as for another disorder that prevails here. It seems to be impregnated chiefly with sulphur and alum. When you approach your ear to the rocks of the Pisciarelli, from whence this water ouzes, you hear a horrid boiling noise, which seems to proceed from the huge cauldron, that may be supposed to be under the plain of the Solfaterra. On the other side of the Solfaterra, next the sea, there is a rock which has communicated with the sea, till part of it was cut away to make the road to Puzzole; this was undoubtedly a considerable lava that ran from the Solfaterra when it was an active volcano. Under this rock of lava, which is more than seventy feet high, there is a stratum of pumice and ashes. This ancient lava is about a quarter of a mile broad; you meet with it abruptly before you come in sight of Puzzole, and it finishes as abruptly within about an hundred paces of the town. I have often thought that many quarries of stone upon examination would be found to owe their origin to the same cause, though
time

time may have effaced all signs of the volcano from whence they proceeded. Except this rock, which is evidently lava and full of vitrifications like that of Vesuvius, all the rocks upon the coast of Baïa are of *tufa*.

I have observed in the lava of Vesuvius and Etna, as in this, that the bottom as well as the surface of it was rough and porous, like the cinders or scorix from an iron foundery, and that for about a foot from the surface and from the bottom, they were not near so solid and compact as towards the centre; which must undoubtedly proceed from the impression of the air upon the vitrified matter whilst in fusion. I mention this circumstance, as it may serve to point out true lava's with more certainty. The ancient name of the Solfaterra was, *Forum Vulcani*, a strong proof of its origin from subterraneous fire. The degree of heat that the Solfaterra has preserved for so many ages, seems to have calcined the stones upon its cone, and in its crater, as they are very white and crumble easily in the hottest parts.

We come next to the new mountain near Puzzole, which, being of so very late a formation, preserves its conical shape entire, and produces as yet but a very slender vegetation. It has a crater almost as deep as the cone is high, which may be near a quarter of a mile perpendicular, and is in shape a regular inverted cone. At the basis of this new mountain (which is more than three miles in circumference), the land upon the sea shore, and even that which is washed by the sea itself, is burning hot for above the space of an hundred yards; if you take up a handful of the

sand below water, you are obliged to get rid of it directly, on account of its intense heat.

I had been long very desirous of meeting with a good account of the formation of this new mountain, because, proving, this mountain to have been raised by meer explosion in a plain, would prove at the same time, that all the neighbouring mountains, which are composed of the same materials, and have exactly or in part the same form, were raised in the like manner, and that the seat of fire, the cause of these explosions, lies deep, which I have every reason to think.

Fortunately, I lately found two very good accounts of the phenomena that attended the explosion, which formed the new mountain, published a few months after the event. As I think them very curious, and greatly to my purpose, and as they are rare, I will give you a literal translation of such extracts as relate to the formation of the Monte Nuovo. They are bound in one volume*.

The title of the first is *Dell'Incendio di Pozzuolo, Marco Antonio delli Falconi all' Illustrissima Signiora Marchesa della Padula nel MDXXXVIII.*

At the head of the second is, *Ragionamento del Terremoto, del Nuovo Monte, del Aprimento di Terra in Pozzuolo nell' Anno 1538. e della significazione d'essi.* Per Pietro Giacomo da Toledo, and at the end of the book, *Stampata in Nap. per Giovanni Sulzbach Alemeno, a 22di Genaro 1539, con gratia, e privilegio.*

" First then (says Marco Antonio delli Falconi),
 " will I relate simply and exactly the operations of

* This very scarce volume has been presented by Mr. Hamilton to the British Museum. M. M.

" nature,

“ nature, of which I was either myself an eye-wit-
 “ nefs, or as they were related to me by those who
 “ had been witnesses of them. It is now two years
 “ that there have been frequent earthquakes at
 “ Pozzuolo, at Naples, and the neighbouring parts;
 “ on the day, and in the night before the appearance
 “ of this eruption, above twenty shocks great and
 “ small were felt at the abovementioned places. The
 “ eruption made its appearance the 29th of Septem-
 “ ber 1538, the feast of St Michael the angel; it was
 “ on a Sunday, about an hour in the night; and as I
 “ have been informed, they began to see on that spot,
 “ between the hot baths or sweating rooms, and
 “ Trepergule, flames of fire, which first made their
 “ appearance at the baths, then extended towards
 “ Trepergule, and fixing in the little valley that lies
 “ between the Monte Barbaro and the hillock called
 “ del Pericolo (which was the road to the lake of
 “ Avernus and the baths), in a short time the fire
 “ increased to such a degree that it burst open the
 “ earth in this place, and threw up so great a quanti-
 “ ty of ashes and pumice stones mixed with water,
 “ as covered the whole country; and in Naples a
 “ shower of these ashes and water fell great part of
 “ the night. The next morning, which was Monday,
 “ and the last of the month, the poor inhabitants of
 “ Pozzuolo, struck with so horrible a sight, quitted
 “ their habitations, covered with that muddy and
 “ black shower, which continued in that country the
 “ whole day, flying death, but with faces painted
 “ with its colours, some with their children in their
 “ arms, some with sacks full of their goods, others
 “ leading an ass loaded with their frightened family
 “ towards

" towards Naples, others carrying quantities of birds
 " of various sorts that had fallen dead at the time the
 " eruption began, others again with fish which they
 " had found, and were to be met with in plenty
 " upon the shore, the sea having been at that time
 " considerably dried up. Don Petro di Toledo, Vice-
 " roy of the kingdom, with many gentlemen, went
 " to see so wonderful an appearance; I also, having
 " met with the most honourable and incomparable
 " gentleman, Signior Fabritio Moramaldo, on the
 " road, went and saw the eruption and the many
 " wonderful effects of it. The sea towards Baia
 " had retired a considerable way; though from the
 " quantity of ashes and broken pumice stones thrown
 " up by the eruption, it appeared almost totally dry.
 " I saw likewise two springs in those lately-discover-
 " ed ruins, one before the house that was the queen's,
 " of hot and salt water; the other of fresh and cold
 " water, on the shore, about 250 paces nearer to the
 " eruption: some say, that still nearer to the spot
 " where the eruption happened, a stream of fresh
 " water issued forth like a little river. Turning to-
 " wards the place of the eruption, you saw mountains
 " of smoke, part of which was very black and part
 " very white, rise up to a great height; and in the
 " midst of the smoke, at times, deep-coloured flames
 " burst forth with huge stones and ashes, and you
 " heard a noise like the discharge of a number of
 " great artillery. It appeared to me as if Typhoeus
 " and Enceladus from Ischia and Etna with innume-
 " rable giants, or those from the Campi Phlegrei
 " (which according to the opinions of some were
 " situated in this neighbourhood), were come to
 " wage

“ wage war again with Jupiter. The natural histo-
 “ rians may perhaps reasonably say, that the wise
 “ poets meant no more by giants, than exhalations,
 “ shut up in the bowels of the earth, which, not
 “ finding a free passage, open one by their own force
 “ and impulse, and form mountains, as those which
 “ occasioned this eruption have been seen to do;
 “ and methought I saw those torrents of burning
 “ smoke that Pindar describes in an eruption of Etna,
 “ now called mon Gibello in Sicily, in imitation of
 “ which, as some say, Virgil wrote these lines :

“ *Ipse sed borrificis juxta tonat Ætna ruinis, &c.*

“ After the stones and ashes with clouds of thick
 “ smoke had been sent up, by the impulse of the
 “ fire and windy exhalation (as you see in a great
 “ cauldron that boils), into the middle region of the
 “ air, overcome by their own natural weight, when
 “ from distances the strength they had received from
 “ impulse was spent, rejected likewise by the cold
 “ and unfriendly region, you saw them fall thick,
 “ and by degrees, the condensed smoke clear away,
 “ raining ashes with water and stones of different
 “ sizes, according to the distance from the place :
 “ then by degrees with the same noise and smoke it
 “ threw out stones and ashes again, and so on by
 “ fits. This continued two days and nights, when
 “ the smoke and force of the fire began to abate.
 “ The fourth day, which was Thursday at 22 o'clock,
 “ there was so great an eruption, that, as I was in
 “ the gulph of Puzzole coming from Ischia, and
 “ not far from Misenum, I saw, in a short time,

“ many columns of smoke shoot up, with the most
 “ terrible noise I ever heard, and, bending over the
 “ sea, came near our boat, which was four miles or
 “ more from the place of their birth; and the quan-
 “ tity of ashes, stones, and smoke, seemed as if they
 “ would cover the whole earth and sea. Stones, great
 “ and small, and ashes more or less, according to the
 “ impulse of the fire and exhalations, began to fall,
 “ so that a great part of this country was covered
 “ with ashes; and many that have seen it, say, they
 “ reached the vale of Diana, and some parts of
 “ Calabria, which are more than 150 miles from
 “ Pozzuolo. The Friday and Saturday nothing but
 “ a little smoke appeared, so that many, taking cou-
 “ rage, went upon the spot, and say, that with the
 “ stones and ashes thrown up, a mountain has been
 “ formed in that valley, not less than three miles in
 “ circumference, and almost as high as the monte
 “ Barbaro, which is near it, covering the Canettaria,
 “ the castle of Trepergule, all those buildings and
 “ the greatest part of the baths that were about
 “ them; extending South towards the sea, North as
 “ far as the lake of Avernus, West to the Sudatory,
 “ and joining East to the foot of the monte Barbaro,
 “ so that this place has changed its form and face in
 “ such a manner as not to be known again, a thing
 “ almost incredible to those who have not seen it,
 “ ~~that in so short a time~~ so considerable a mountain
 “ could have been formed. On its summit there is a
 “ mouth in the form of a cup, which may be a
 “ quarter of a mile in circumference, though some
 “ say it is as large as our market-place at Naples, from
 “ which there issues a constant smoke; and though

“ I have seen it only at a distance, it appears very
 “ great. The Sunday following, which was the
 “ 6th of October, many people going to see this
 “ phænomenon, and some having ascended half the
 “ mountain, others more, about 22 o'clock there
 “ happened so sudden and horrid an eruption, with
 “ so great a smoke, that many of these people were
 “ stifled, some of which could never be found. I
 “ have been told, that the number of the dead or
 “ lost amounted to twenty four. From that time
 “ to this, nothing remarkable happened; it seems
 “ as if the eruption returned periodically, like
 “ the ague or gout. I believe henceforward it
 “ will not have such force, though the eruption
 “ of the Sunday was accompanied with showers
 “ of ashes and water, which fell at Naples, and
 “ were seen to extend as far as the mountain of
 “ Somma, called Vesuvius by the ancients; and,
 “ as I have often remarked, the clouds of smoke
 “ proceeding from the eruption, moved in a
 “ direct line towards that mountain, as if these
 “ places had a correspondence and connection one
 “ with the other. In the night, many beams and
 “ columns of fire were seen to proceed from this
 “ eruption, and some like flashes of lightening.
 “ We have then, many circumstances for our obser-
 “ vation, the earthquakes, the eruption, the drying
 “ up of the sea, the quantity of dead fish and birds,
 “ the birth of springs, the shower of ashes with
 “ water, and without water, the innumerable trees
 “ in that whole country, as far as the Grotto of
 “ Lucullus, torn from their roots, thrown down, and
 “ covered with ashes, that it gave one pain to see
 Vol. LXI. E “ them:

“ them : and as all these effects were produced by
 “ the same cause that produces earthquakes ; let us
 “ first enquire how earthquakes are produced, and
 “ from thence we may easily comprehend the cause
 “ of the abovementioned events.” Then follows a
 dissertation on earthquakes, and some curious con-
 jectures relative to the phænomena which attended
 this eruption, clearly and well expressed, considering,
 as the author himself apologizes, that at that time the
 Italian language had been little employed on such
 subjects.

The account of the formation of the monte
 Nuovo, by Pietro Giacomo di Toledo, is given in a
 dialogue between the feigned personages of Peregrino
 and Sveffano ; the former of which says, “ It is now
 “ two years that this province of Campagna has been
 “ afflicted with earthquakes, the country about
 “ Pozzuolo much more so than any other parts, but
 “ the 27th and the 28th of the month of September
 “ last, the earthquakes did not cease day or night, in
 “ the abovementioned city of Pozzuolo ; that plain
 “ which lies between the lake of Averno, the monte
 “ Barbaro, and the sea, was raised a little, and many
 “ cracks were made in it, from some of which
 “ issued water ; and at the same time the sea, which
 “ was very near the plain, dried up about two hun-
 “ dred paces, so that the fish were left on the sand,
 “ a prey to the inhabitants of Pozzuolo. At last, on
 “ the 29th of the said month, about two hours in
 “ the night, the earth opened near the lake, and dis-
 “ covered a horrid mouth, from which were vomited
 “ furiously, smoke, fire, stones, and mud composed
 “ of ashes ; making, at the time of its opening, a
 “ noise

“ noise like very loud thunder : the fire that issued
 “ from this mouth, went towards the walls of the
 “ unfortunate city ; the smoke was partly black and
 “ partly white, the black was darker than darkness
 “ itself, and the white was like the whitest cotton ;
 “ these smokes, rising in the air, seemed as if they
 “ would touch the vault of heaven ; the stones that
 “ followed, were, by the devouring flames, con-
 “ verted to pumice, the size of which (of some I say)
 “ were much larger than an ox. The stones went
 “ about as high as a cross-bow can carry, and then
 “ fell down, sometimes on the edge and sometimes
 “ into the mouth itself. It is very true that many of
 “ them in going up could not be seen, on account
 “ of the dark smoke ; but when they returned from
 “ the smoky heat, they shewed plainly where they
 “ had been by their strong smell of fetid sulphur,
 “ just like stones that have been thrown out of a
 “ mortar, and have passed through the smoke of in-
 “ flamed gunpowder. The mud was of the colour
 “ of ashes, and at first very liquid, then by degrees
 “ less so, and in such quantities, that in less than
 “ twelve hours, with the help of the abovementioned
 “ stones, a mountain was raised of a thousand paces
 “ in height. Not only Pozzuolo and the neighbour-
 “ ing country was full of this mud, but the city of
 “ Naples also, the beauty of whose palaces were, in
 “ a great measure, spoiled by it. The ashes were
 “ carried as far as Calabria by the force of the
 “ winds, burning up in their passage the grass and
 “ small trees, many of which were borne down by the
 “ weight of them. An infinity of birds also, and
 “ numberless animals of various kinds, covered with

“ this sulphureous mud, gave themselves up a prey
 “ to man. Now this eruption lasted two nights and
 “ two days without intermission, though, it is true,
 “ not always with the same force, but more or less,
 “ when it was at its greatest height, even at Naples
 “ you heard a noise or thundering like heavy artillery
 “ when two armies are engaged. The third day
 “ the eruption ceased, so that the mountain made its
 “ appearance uncovered, to the no small astonish-
 “ ment of every one who saw it. On this day,
 “ when I went up with many people to the top of
 “ this mountain; I saw down into its mouth, which
 “ was a round concavity of about a quarter of a mile
 “ in circumference, in the middle of which the
 “ stones that had fallen were boiling up, just as, in
 “ a great cauldron of water that boils on the fire.
 “ The fourth day, it began to throw up again, and
 “ the seventh much more, but still with less violence
 “ than the first night; it was at this time that many
 “ people, who were unfortunately on the mountain,
 “ were either suddenly covered with ashes, smothered
 “ with smoke, or knocked down by stones, burnt by
 “ the flame, and left dead on the spot. The smoke
 “ continues to this day, and you often see in the night
 “ time fire in the midst of it. Finally, to complete
 “ the history of this new and unforeseen event, in
 “ many parts of the new-made mountain, sulphur
 “ begins to be generated.” Giacomo di Toledo,
 towards the end of his dissertation upon the pheno-
 mena attending this eruption, says, that the lake of
 Avernus had a communication with the sea, before
 the time of the eruption; and that he apprehended
 that the air of Puzzole might come to be affected in
 summer

summer time, by the vapours from the stagnated waters of the lake, which is actually the case.

You have, Sir, from these accounts, an instance of a mountain, of a considerable height and dimensions, formed in a plain, by mere explosion, in the space of forty-eight hours. The earthquakes having been sensibly felt at a great distance from the spot where the opening was made, proves clearly, that the subterraneous fire was at a great depth below the surface of the plain; it is as clear that those earthquakes, and the explosion, proceeded from the same cause, the former having ceased upon the appearance of the latter. Does not this circumstance evidently contradict the system of M. Buffon, and of all the natural historians, who have placed the seat of the fire of volcanos towards the center, or near the summit of the mountains, which they suppose to furnish the matter emitted? Did the matter which proceeds from a volcano in an eruption come from so inconsiderable a depth as they imagine, that part of the mountain situated above their supposed seat of the fire must necessarily be destroyed, or dissipated in a very short time: on the contrary, an eruption usually adds to the height and bulk of a volcano, and who, that has had an opportunity of making observations on volcanos does not know, that the matter they have emitted for many ages, in lavas, ashes, smoke, &c. could it be collected together, would more than suffice to form three such mountains as the simple cone or mountain of the existing volcano? With respect to Vesuvius, this could be plainly proved; and I refer to my letter upon the subject of Etna, to shew the quantity of matter thrown up in one eruption,

tion, by that terrible volcano. Another proof that the real seat of the fire of volcanos lies even greatly below the general level of the country whence the mountain springs, is, that was it only at an inconsiderable depth below the basis of the mountain, the quantity of matter thrown up would soon leave so great a void immediately under it, that the mountain itself must undoubtedly sink and disappear after a few eruptions.

In the above accounts of the formation of the new mountain, we are told that the matter first thrown up, was mud composed of water and ashes, mixed with pumice stones and other burnt matter: on the road leading from Puzzole to Cuma, part of the cone of this mountain has been cut away to widen the road. I have there seen that its composition is a *tufa* intermixed with pumice, some of which are really of the size of an ox, as mentioned in Toledo's account, and exactly of the same nature as the *tufa* of which every other high ground in its neighbourhood is composed; similar also to that which covers Herculaneum. According to the above accounts, after the muddy shower ceased, it rained dry ashes: this circumstance will account for the strata of loose pumice and ashes, that are generally upon the surface of all the *tufas* in this country, and which were most probably thrown up in the same manner. At the first opening of the earth, in the plain near Puzzole, both accounts say, that springs of water burst forth; this water, mixing with the ashes, certainly occasioned the muddy shower; when the springs were exhausted, there must naturally have ensued a shower of dry ashes and pumice, of which we have been likewise

likewise assured. I own, I was greatly pleased at being in this manner enabled to account so well for the formation of these *tufa* stones and the veins of dry and loose burnt matter above them, of which the soil of almost the whole country I am describing is composed; and I do not know that any one has ever attended to this circumstance, though I find that many authors, who have described this country, have suspected that parts of it were formed by explosion. Wherever then this sort of *tufa* is found, there is certainly good authority to suspect its having been formed in the same manner as the *tufa* of this new mountain; for, as I said before, nature is generally uniform in all her operations.

It is commonly imagined that the new mountain rose out of the Lucrine lake which was destroyed by it; but in the above account, no mention is made of the Lucrine lake; it may be supposed then, that the famous dam, which Strabo and many other ancient authors mention to have separated that lake from the sea, had been ruined by time or accident, and that the lake became a part of the sea before the explosion of 1538.

If the above described eruption was terrible, that which formed the monte Barbaro (or Gauro, as it was formerly called), must have been dreadful indeed. It joins immediately to the new mountain, which in shape and composition it exactly resembles; but it is at least three times as considerable. Its crater cannot be less than six miles in circumference; the plain within the crater, one of the most fertile spots I ever saw, is about four miles in circumference; there is an entrance to this plain, but one on the East

East side of the mountain, made evidently by art; in this section you have an opportunity of seeing that the matter, of which the mountain is composed is exactly similar to that of the monte Nuovo. It was this mountain that produced (as some authors have supposed) the celebrated Falernian wine of the ancients.

Cuma, allowed to have been the most ancient city of Italy, was built on an eminence, which is likewise composed of *tufa*, and may be naturally supposed a section of the cone formed by a very ancient explosion.

The lake of Avernus fills the bottom of the crater of a mountain, undoubtedly produced by explosion, and whose interior and exterior form, as well as the matter of which it is composed, exactly resemble the monte Barbaro and monte Nuovo. At that part of the base of this mountain which is washed by the sea of the bay of Puzzole, the sand is still very hot, though constantly washed by the waves; and into the cone of the mountain, near this hot sand, a narrow passage of about 100 paces in length is cut, and leads to a fountain of boiling water, which, though brackish, boils fish and flesh without giving them any bad taste or quality, as I have experienced more than once. This place is called Nero's bath, and is still made use of for a sudatory, as it was by the ancients; the stream that rises from the hot fountain above-mentioned, confined in the narrow subterraneous passage, soon produces a violent perspiration upon the patient who sits therein. This bath is reckoned a great specifick in that distemper which is supposed to have

made its appearance at Naples, before it spread its contagion over the other parts of Europe.

Virgil and other ancient authors say, that birds could not fly with safety over the lake of Avernus, but that they fell therein; a circumstance favouring my opinion that this was once the mouth of a volcano. The vapour of the sulphur and other minerals must undoubtedly have been more powerful the nearer we go back to the time of the explosion of the volcano; and I am convinced that there are still some remains of those vapours upon this lake, as I have observed there are very seldom any water fowl upon it; and that when they do go there, it is but for a short time, whilst all the other lakes in the neighbourhood are constantly covered with them, in the winter season. Upon mount Vesuvius, in the year 1766, during an eruption, when the air was impregnated with noxious vapours, I have myself picked up dead birds frequently.

The castle of Baiâ stands upon a considerable eminence, composed of the usual *tufa* and strata of pumice and ashes, from which I concluded I should find some remains of the craters from whence the matter issued; accordingly, having ascended the hill, I soon discovered two very visible craters, just behind the castle.

The lake called the Mare morto was also, most probably, the crater from whence issued the materials which formed the Promontory of Misenum, and the high grounds around this lake. Under the ruins of an ancient building near the point of Misenum, in a vault, there is a vapour, or *mosfete*, exactly similar in

its effects to that of the Grotto del Cane, as I have often experienced.

The form of the little island of Nisida shews plainly its origin. It is half a hollow cone of a volcano cut perpendicularly; the half crater forms a little harbour called the Porto Pavone; I suppose the other half of the cone to have been detached into the sea by earthquakes, or perhaps by the violence of the waves, as the part that is wanting is the side next to the open sea.

The fertile and pleasant island of Procita shews also most evident signs of its production by explosion, the nature of its soil being directly similar to that of Baïa and Puzzole; this island seems really, as was imagined by the ancients, to have been detached from the neighbouring island of Ischia.

There is no spot, I believe, that could afford a more ample field for curious observations, than the island of Ischia, called Enaria, Inarime, and Pithecusa, by the ancients. I have visited it three times; and this summer passed three weeks there, during which time, I examined, with attention, every part of it. Ischia is eighteen miles in circumference: the whole of its soil is the same as that near Vesuvius, Naples, and Puzzole. There are numberless springs, hot, warm, and cold, dispersed over the whole island, the waters of which are impregnated with minerals of various sorts; so that, if you give credit to the inhabitants of the country, there is no disorder but what finds its remedy here. In the hot months (the season for making use of these baths), those who have occasion for them flock hither from Naples.

A chari-

A charitable institution sends and maintains three hundred poor patients at the baths of Gurgitelli every season. By what I could learn of these poor patients, those baths have really done wonders, in cases attended with obstinate tumours, and in contractions of the tendons and muscles. The patient begins by bathing, and then is buried in the hot sand near the sea. In many parts of the island, the sand is burning hot, even under water. The sand on some parts of the shore is almost entirely composed of particles of iron ore; at least they are attracted by the load-stone, as I have experienced. Near that part of the island called Lacco, there is a rock of an ancient lava, forming a small cavern, which is shut up with a door; this cavern is made use of to cool liquors and fruit, which it does in a short time as effectually as ice. Before the door was opened, I felt the cold to my legs very sensibly; but when it was opened, the cold rushed out so as to give me pain, and within the grotto it was intolerable. I was not sensible of wind attending this cold; though upon mount Etna and mount Vesuvius, where there are caverns of this kind, the cold is evidently occasioned by a subterraneous wind: the natives call such places *ventaroli*. May not the quantity of nitre, with which all these places abound, account in some measure for such extreme cold? My thermometer was unluckily broken, or I would have informed you of the exact degree of the cold in this *ventaroli* of Ischia, which is by much the strongest in its effects I ever felt. The ancient lavas of Ischia shew, that the eruptions there have been very formidable; and history informs us, that its first inhabitants were driven out of the island

by the frequency and the violence of them. There are some of these ancient lavas not less than two hundred feet in depth. The mountain of St. Nicola, on which there is at present a convent of hermits, was called by the ancients Epomeus; it is as high, if not higher, than Vesuvius, and appears to me to be a section of the cone of the ancient and principal volcano of the island, its composition being all *tufa* or lava. The cells of the convent abovementioned are cut out of the mountain itself; and there you see plainly that its composition no way differs from the matter that covers Herculaneum, and forms the monte Nuovo. There is no sign of a crater on the top of this mountain, which rises almost to a sharp point; time, and other accidents, may be reasonably supposed to have worn away this distinctive mark of its having been formed by explosion, as I have seen to be the case in other mountains, formed evidently by explosion, on the flanks of Etna and Vesuvius. Strabo, in his 5th book, upon the subject of this island, quotes Timæus, as having said, that, a little before his time, a mountain in the middle of Pithecusa, called Epomeus, was shook by an earthquake, and vomited flames.

There are many other rising grounds in this island, that, from the nature of their composition, must lead one to think the same as to their origin. Near the village of Castiglione, there is a mountain formed surely by an explosion of a much later date, having preserved its conical form and crater entire, and producing as yet but a slender vegetation: there is no account, however, of the date of this eruption. Nearer the town of Ischia, which is on the sea shore,

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at a place called *Le Cremate*, there is a crater, from which, in the year 1301 or 1302, a lava ran quite into the sea; there is not the least vegetation on this lava, but it is nearly in the same state as the modern lavas of Vesuvius. Pontano, Maranti, and D. Francesco Lombardi, have recorded this eruption; the latter of whom says, that it lasted two months, that many men and beasts were killed by the explosion, and that a number of the inhabitants were obliged to seek for refuge at Naples and in the neighbouring islands. In short, according to my idea, the island of Ischia must have taken its rise from the bottom of the sea, and been increased to its present size by divers later explosions. This is not extraordinary, when history tells us (and from my own observation I have reason to believe) that the Lipary islands were formed in the like manner. There has been no eruption in Ischia since that just mentioned, but earthquakes are very frequent there; two years ago, as I was told, they had a very considerable shock of an earthquake in this island.

Father Goree's account of the formation of the new island in the Archipelago (situated between the two islands called Kammeni, and near that of Santorini) of which he was an eye-witness, strongly confirms the probability of the conjectures I venture to send you, relative to the formation of those islands and that part of the continent above described: it seems likewise to confirm the accounts given by Strabo, Pliny, Justin, and other ancient authors, of many islands in the Archipelago, formerly called the Cyclades, having sprung up from the bottom of the sea in the like manner. According to Pliny, the

4th.

4th year of the cxxxv Olympiad, 237 years before the Christian æra, the island of Thera (now Santorini) and Theresia were formed by explosion; and, 130 years later, the island Hieria (now called the great Kammeni) rose up. Strabo describes the birth of this island in these words: "In the middle space between Thera and Theresia flames burst out of the sea for four days, which, by degrees, throwing up great masses, as if they had been raised by machines, they formed an island of twelve stadia in circuit." And Justin says of the same island, *Eodem anno inter insulas Theramenem et Thersiam, medio utriusque ripæ et maris spatio, terræ motus fuit: in quo, cum admiratione navigantium, repente ex profundo cum calidis aquis Insula emerfit.*

Pliny mentions also the formation of Aspronisi, or the White Island, by explosion, in the time of Vespasian. It is known, likewise, that in the year 1628, one of the islands of the Azores, near the island of St. Michael, rose up from the bottom of the sea, which was in that place 160 fathoms deep; and that this island, which was raised in fifteen days, is three leagues long, a league and a half broad, and rises three hundred and sixty feet above water.

Father Gorce, in his account of the formation of the new island in the Archipelago, mentions two distinct matters that entered into the composition of this island, the one black, the other white. Aspronisi, probably from its very name, is composed of the white matter, which if, upon examination, should prove to be a *tufa*, as I strongly suspect, I should think myself still more grounded in my conjectures; though I must confess, as it is, I have scarcely a doubt

doubt left with respect to the country I have been describing having been thrown up in a long series of ages by various explosions from subterraneous fire. Surely there are at present many existing volcanos in the known world; and the memory of many others have been handed down to us by history. May there not therefore have been many others of such ancient dates as to be out of the reach of history?

Such wonderful operations of nature are certainly intended by all-wise Providence for some great purpose. They are not confined to any one part of the globe, for there are volcanos existing in the four quarters of it. We see the great fertility of the soil thrown up by explosion, in part of the country I have described, which on that account was called by the ancients *Campania Felix*. The same circumstance is evident in Sicily, justly esteemed one of the most fertile spots in the world, and the granary of Italy. May not subterraneous fire be considered as the great plough (if I may be allowed the expression) which nature makes use of to turn up the bowels of the earth, and afford us fresh fields to work upon, whilst we are exhausting those we are actually in possession of, by the frequent crops we draw from them? Would it not be found, upon enquiry, that many precious minerals must have remained far out of our reach, had it not been for such operations of nature? It is evidently so in this country. But such great enquiries would lead me far indeed. I will only add a reflection, which my own little experience in this branch of natural history furnishes me with. It is, that we are apt to judge of the great operations of nature on too confined a plan. When first I came to Naples,

my

my whole attention, with respect to natural history, was confined to mount Vesuvius, and the wonderful phenomena attending a burning mountain; but, in proportion as I began to perceive the evident marks of the same operation having been carried on in the different parts above described, and likewise in Sicily, in a greater degree, I looked upon mount Vesuvius only as a spot on which nature was at present active, and thought myself fortunate in having an opportunity of seeing the manner in which one of her great operations (an operation, I believe, much less out of her common course than is generally imagined) was effected.

Such remarks as I have made on the eruptions of mount Vesuvius, during my residence at Naples, have been transmitted to the Royal Society, who have done them more honour than they deserved. Many more might be made upon this active volcano, by a person who had leisure, a previous knowledge of the natural history of the earth, a knowledge of chemistry, and was practised in physical experiments, particularly those of electricity. I am convinced that the smoke of volcanos contains always a portion of electrical matter, which is manifest at the time of great eruptions, as is mentioned in my account of the great eruption of Vesuvius in 1767. The peasants in the neighbourhood of my villa, situated at the foot of Vesuvius, have assured me, that, during the eruption last mentioned, they were more alarmed by the lightning and balls of fire that fell about them with a crashing noise, than by the lava and the usual attendants of an eruption. I find in all the accounts of great eruptions mention made of this sort of lightning,

lightening which is distinguished here by the name of *Ferilli*. Bracini, in his account of the great one of Vesuvius in 1631, says, that the column of smoke, which issued from its crater, went over near an hundred miles of country, and that several men and beasts were struck dead by lightening, issuing from this smoke in its course.

The nature of the noxious vapours, called here *mosfete*, that are usually set in motion by an eruption of the volcano, and are then manifest in the wells and subterraneous parts of its neighbourhood, seem likewise to be little understood. From some experiments very lately made, by the ingenious Dr. Nuth, on the *mosfete* of the Grotto del Cane, it appears that all its known qualities and effects correspond with those attributed to fixed air. Just before the eruption of 1767, a vapour of this kind broke into the king's chapel at Portici, by which a servant, opening the door of it, was struck down. About the same time, as his Sicilian majesty was shooting in a paddock near the palace, a dog dropped down, as was supposed, in a fit; a boy going to take him up dropped likewise; a person present, suspecting the accident to have proceeded from a *mosfete*, immediately dragged them both from the spot where they lay, in doing which, he was himself sensible of the vapour; the boy and the dog soon recovered. His Sicilian majesty did me the honour of informing me himself of this accident soon after it had happened. I have met with these *mosfetes* often, when I have been making my observations on the borders of mount Vesuvius,

particularly in caverns, and once on the Solfaterra. The vapour affects the nostrils, throat, and stomach, just as the spirit of hartshorn, or any strong volatile salts, and would soon prove fatal if you did not immediately remove from it. Under the ancient city of Pompeii, the *mosfetes* are very frequent and powerful, so that the excavations that are carrying on there are often interrupted by them; at all times *mosfetes* are to be met with under ancient lavas of Vesuvius, particularly those of the great eruption of 1631. In Serao's account of the eruption of 1737, and in the chapter upon *mosfetes*, he has recorded several curious experiments relative to this phenomenon. The Canonico Recupero, who, as I mentioned to you in a former letter, is watching the operations of mount Etna, has just informed me, that a very powerful *mosfete* has lately manifested itself in the neighbourhood of Etna; and that he found near the spot from whence it rises, animals, birds, and insects, dead, and the stronger sort of shrubs blasted, whilst the grass and tenderer plants did not seem to be affected. The circumstance of this *mosfete*, added to that of the frequent earthquakes felt lately at Rhegio and Messina, makes it probable that an eruption of mount Etna is at hand.

I am alarmed at the length of this letter. By endeavouring to make myself clearly understood, I have been led to make, what I thought, necessary digressions. I must therefore beg of your goodness, that, should you find this memoir in its present state, too tedious (which I greatly apprehend) to be presented

presented to our respectable Society, you will make only such extracts from it as you shall think will be most agreeable and interesting. I am,

S I R,

With great truth and regard,

Your most obedient humble servant,

William Hamilton.

REFERENCES to the MAP, TAB. I.

1. Naples.
2. Portici.
3. Refina, under which Herculaneum is buried.
4. Torre del Greco.
5. Hermitage, at which travellers usually rest, in their way up mount Vesuvius.
6. St. Angelo, a convent of Calmaldolese, situated upon a cone of a mountain formed by an ancient explosion.
7. Cones formed by the eruption of 1760, and lava that ran from them almost into the sea.
8. Mount Vesuvius and Somma.
9. Village of Somma.
10. The convent of the Madona del Arco, under which lavas have been found at 300 feet depth, and which must have proceeded from the mountain of Somma, when an active volcano.
11. Ottaiano.
12. Torre del Annunziata.
13. Castel a Mare, near which the ancient town of Stabia is buried, and where Pliny the elder lost his life.
14. Vico.
15. Sorrento, and the plain formed evidently by subterraneous fire.
16. ~~Mafia~~.
17. Island of Caprea.
18. The

18. The Grotto of Paufilipo, cut through the mountain anciently, to make a road from Naples to Puzzole.
19. Point of Paufilipo.
20. The Gaiola, where there are ruins of ancient buildings, supposed to have belonged to Lucullus.
21. The island of Nifida, evidently formed by explosion.
22. The Lazaret.
23. The Bagnoli.
24. Puzzole, or Pozzuolo.
25. The Solfaterra, anciently called Forum Vulcani : between the Solfaterra and the lake of Agnano, are the boiling waters of the Pisciarelli.
26. The New Mountain, formed by explosion in the year 1538; the sand of the sea shore at its basis burning hot.
27. The lake of Agnano, supposed the crater of an ancient volcano : here are the baths called St. Germano, and the famous Grotto del Cane.
28. Astruni, which has been evidently a volcano, and is now a Royal Chace, the crater being surrounded with a wall.
29. The monte Gauro or Barbaro, anciently a volcano.
30. The lake of Avernus, evidently the crater of an ancient volcano.
31. Lake of Fufaro.
32. Point of Misenum, from whence Pliny the elder discovered the eruption of Vesuvius that proved fatal to him ; near this place, in a vault of an ancient building, is a constant vapour
or

or *mofete*, of the same quality with that of the Grotto del Cane.

33. The Mare Morto, the ancient Roman Harbour.
34. Baia; behind the castle are two evident craters of ancient volcanos.
35. Island of Procita.
36. A perfect cone and crater of a volcano near Castiglione in the island of Ischia.
37. Lava that ran into the sea in the last eruption on this island, in the year 1301, or 1302; the place now called Le Cremate.
38. Town of Ischia and castle.
39. Lake of Licola.
40. Lake of Patria.
41. The river Volturnus.
42. Capua.
43. Caserta.
44. Aversa.
45. Mataloni.
46. Acerra.
47. Island of Ischia, anciently called *Ænaria*, *Inarime*, and *Pithecula*.
48. The mountain of St. Nicola, anciently called *Mons Epomeus*, supposed the remains of the principal volcano of the island.
49. Castiglione, near which are the baths of *Gurgitelli*.
50. Lacco, near which is that very cold vapour called by the natives *ventarole*.
51. Ancient city of Pompeii, where his Sicilian majesty's excavations are carrying on at present.
52. Rovigliano.
53. River of Sarno.

54. Cuma.
 55. Hot sands and Sudatory called Nero's baths.
 56. The Lucrine lake supposed to have been here,
and of which there is still some little remain.
 57. Villa Angelica, Mr. Hamilton's villa, from
whence he has made many of his observations upon mount Vesuvius.
 58. Cones formed by an ancient eruption called
viuli; here are likewise cold vapours called
ventaroli.
 59. High grounds, probably sections of cones of ancient volcanos, being all composed of *tufa* and strata of loose pumice and burnt matter.
 60. Plain of the Campagna Felice, four or five feet
of excellent soil, under which are strata of
burnt and erupted matter.
- Marks the boundary of Mr. Hamilton's observations.

II. *Extract of another Letter, from Mr. Hamilton, to Dr. Maty, on the same Subject.*

Naples, March 5, 1771.

Read May 30, 1771. **S**INCE I had the pleasure of sending you my letter, in which the nature of the soil of more than twenty miles round this capital is described; examining a deep hollow way cut by the rain waters into the outside cone of the Solfaterra, I discovered, that a great part of the cone of that ancient volcano has been calcined by the hot vapours above described. Pumice calcined seems to be the chief ingredient, of which several specimens of (as I suppose) variegated uniform marble are composed, and the beautiful variegations in them may have probably been occasioned by the mineral vapours. As these specimens are now sent to the Royal Society, you will see that these variegations are exactly of the same pattern and colours as are met in many marbles and flowered alabasters; and I cannot help thinking that they are marble or alabaster in its infant state. What a proof we have here of the great changes the earth we inhabit is subject to! What is now the Solfaterra, we have every reason to suppose, to have been originally thrown up by a subterraneous explosion from the bottom of the sea. That it was long

an existing volcano, is plain, from the ancient currents of lava, that are still to be traced from its crater to the sea, from the strata of pumice and erupted matter, of which its cone, in common with those of all other volcanos, is composed, and from the testimony of many ancient authors. Its cone in many parts has been calcined, and is still calcining, by the hot vapours that are continually issuing forth through its pores, and its nature is totally changed by this chemical process of nature. In the hollow way, where I made these remarks, you see the different strata of erupted matter, that compose the cone in some places perfectly calcined, in others not, according as the vapours have found means to insinuate themselves more or less.

A hollow way cut by the rains on the back of the mountain, on which part of Naples is situated, towards Capo di China, shews that the mountain is composed of strata of erupted matter, among which are large masses of bitumen, in which its former state of fluidity is very visible. Here it was I discovered that pumice stone is produced from bitumen, which I believe has not yet been remarked. Some specimens shew evidently the gradual process from bitumen to pumice; and you will observe that the crystalline vitrifications, that are visible in the bitumen, suffer no alteration, but remain in the same state in the perfect pumice as in the bitumen.

In a piece of stratum, calcined from the outside of the Solfaterra, the form and texture of the pumice stones is very discernible. In several parts of the outside cone, this calcining operation is still carried on by the exhalation of constant very hot

and damp vapours, impregnated with salts, sulphur, alum, &c. Where the above-mentioned vapours have not operated, the strata of pumice and erupted matter, that compose the cone of the Solfaterra, are like those of all the high grounds in its neighbourhood, which I suppose to have been thrown up likewise by explosion. I have seen here, half of a large piece of lava perfectly calcined, whilst the other half out of the reach of the vapours has been untouched; and in some pieces the center seems to be already converted into true marble.

The variegated specimens then, above described, are nothing more than pumice and erupted matter, after having been acted upon in this manner by the hot vapours; and if you consider the process, as I have traced it, from bitumen to pumice, and from pumice to marble, you will think with me that it is difficult to determine the primitive state of the many wonderful productions we see in nature.

I found in the *tufa* of the mountain of Paufilipo, a fragment* of lava: one side I polished, to shew it to be true lava; the other shews the signs of the *tufa*, with which it is incorporated. It has evidently been rounded by friction, and most probably by rolling in the sea. Is it not natural then to imagine that there must have been volcanoes near this spot, long before the formation of the mountain of Paufilipo? This little stone may perhaps raise in your mind such reflections, as it did in mine, relative to the great changes our globe suffers, and the probability of its great antiquity.

III. *A Letter from Dr. Franklyn, F. R. S. to the Astronomer Royal; containing an Observation of the Transit of Mercury over the Sun, November 9th 1769: By John Winthrop, Esq; F. R. S. Hollisian Professor of Mathematics and Natural Philosophy at Cambridge, New England.*

DEAR SIR,

Craven-street, Feb. 12, 1770.

Read Jan. 10, 1771. **I** HAVE just received a letter from Mr. Winthrop, dated Dec. 7, containing the following account, viz.

“ On Thursday the 9th of November, I had an opportunity of observing a transit of Mercury. I had carefully adjusted my clock to the apparent time, by correspondent altitudes of the Sun, taken with the quadrant for several days before, and with the same reflecting telescope as I used for the transit of Venus *. I first perceived the little planet making an impression on the Sun’s limb at $2^h 52' 41''$; and he appeared wholly within at $53' 58''$ apparent time. The sun set before the planet reached the middle of his course; and for a con-

* See Phil. Transact. Vol. LIX. p. 352.

“ fiderable time before funfet, it was fo cloudy, that
 “ the planet could not be difcerned. So that I made
 “ no obfervations of confequence except that of the
 “ beginning, at which time the Sun was perfectly
 “ clear. This tranfit compleats three periods of
 “ 46 years, fince the firft obfervation of Caffendi at
 “ Paris, in 1631.”

I am, S-I R,

With great efteem,

Your moft obedient fervant,

B. Franklin.

IV. *Observations on the Heat of the Ground on Mount Vesuvius: By John Howard, Esq; F. R. S.*

Read Jan. 17, 1771. **I** BEG leave to lay before this Society, some observations which I made last June, on the heat of the ground on mount Vesuvius, near Naples.

On my ascending the mountain, I often immersed the bulb of a thermometer in the ground, but found no sensible heat for some time: the first rising in my thermometer, was 114° ; every two or three minutes, I observed the instrument, till I gained the summit. At those times, I found it rising to 122° , 137° , 147° , 164° , and 172° : on the top, in two places, where I made the observations, in the interstices betwixt the hard lava, it was 218° . Such a degree of heat, after I had overcome the inconvenience of the exhalations, raised my curiosity to know if there was a still greater degree of heat in the mouth of the said mountain. Accordingly, I made a small descent, and, by two observations I carefully and attentively made, my thermometer both times stood at 240° .

John Howard.

P. S. If it should be asked, how a person, either to their feet or in stooping or laying down to make the observations, could endure such a degree of heat; I answer, that the heat, both at top and in the mouth of the mountain, was only in particular places. This was known by the fumes; the hard masses of lava are only warm, and even so tolerable as to permit me, to lay on them, as I was often obliged to do, when the thermometer was immersed, to make a true observation.

Phalacrocorax Volini TAIL 11-35.



V. *Description of a Bird from the East Indies; in a Letter to James West, Esq; President of the Royal Society; from Mr. George Edwards, F. R. S.*

S I R,

Read Jan. 17, 1771. **I**N August last, a friend of mine carried me with him to Valentine House, near Ilford in Essex, the seat of Charles Raymond, Esq; to see some curious birds and other animals, from the East Indies; amongst these, I discovered a rare bird, not before known to me*. It is of a new genus, and the only species of the genus hitherto come to my knowledge. It is about the bigness of a heron [see TAB. II.]; and has a good deal of the appearance of birds of the heron and crane kind, except that the neck is a little shorter. On first sight, I thought the bird belonged to that genus; but, on a closer view, I judged it to be no wader in the water, for though the legs be as long or longer than in herons, &c. yet they are feathered down to the knees, which we do not find in birds who wade in shallow waters, to seek their

* This bird was described, under the name of the *Sagittarius* from the Cape of good Hope, by Mr. Vosmaer, keeper of the Statholder's Museum at the Hague, in one of his publications in low Dutch, printed at Amsterdam, 1769, in 4to, with a coloured cut of the said bird. It seems to feed equally on flesh and fish; which accounts for his uniting the characters of birds of prey, and of waders in water. M. M.

food.

food. The toes in this bird are also much shorter than they are in herons, so that I think it must be placed amongst land birds. The bill is exactly like those of hawks, and other birds of prey, which is the only instance I have discovered in any of the long legged kind of birds; the talons or claws are small and unfit for a bird of prey, and the eyes are of a dark colour placed in spaces covered with a bare skin of an orange colour, on each side of the head. It hath a beautiful crest composed of many long painted feathers tipped with black hanging backward. The beak, head, neck, back, breast, and upper covert feathers of the wings are of a blueish ash colour, rather lighter on the breast than on the back. The belly, thighs, the greater wing-feathers, and tail, are black, the tail feathers being tipped with white; the legs and feet are of a reddish flesh colour, the claws black. This bird was called a snake-eater, by those who brought it from India. I believe it may prey on small serpents, lizards, and other small reptiles. Another bird was brought with this, supposed to be the male of this species, which died soon after it was landed. Mr. Raymond's servant told me that it was something larger, and the crest longer, the head black, but that in other respects the two birds agreed.

I am, S I R,

Your most humble servant,

College of Physicians,
January, 1771.

Geo. Edwards.

VI. *An Extract from the Register of the Parish of Holy-Cross in Salop, being a Second * Decade of Years from Michaelmas, 1760, to Michaelmas, 1770, carefully digested in the following Table, by the Rev. William Gorfuch, Minister of that Parish.*

Read January 24, 1771.

		1761.	1762.	1763.	1764.	1765.	1766.	1767.	1768.	1769.	1770.	Total.
Baptized,	Males.	17	18	20	18	19	23	22	17	22	18	194
	Females.	14	20	22	21	19	16	30	9	20	17	88
Buried.	Males.	11	11	16	14	19	33	11	19	12	15	161
	Females.	14	13	20	13	19	54	18	20	14	19	204

Increase 17.

	m. Males.												f. Females.												Total
	1761	1762	1763	1764	1765	1766	1767	1768	1769	1770			1761	1762	1763	1764	1765	1766	1767	1768	1769	1770			
Under a month	3	12	00	33	00	21	51	10	2	—	1	0	—	—	—	—	—	—	—	—	—	—	—	—	25
From a month to a year	2	10	23	33	22	06	52	25	51	03	1	03	—	—	—	—	—	—	—	—	—	—	—	—	48
From 1 to 2	2	1	1	3	3	1	3	3	1	3	2	24	—	—	—	—	—	—	—	—	—	—	—	—	39
2	5	1	0	1	2	1	2	0	1	2	3	23	—	—	—	—	—	—	—	—	—	—	—	—	23
5	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
10	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
15	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
20	25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
25	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
30	35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14
35	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16
40	45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
45	50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
50	55	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15
55	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
60	65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18
65	70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
70	75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13
75	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23
80	85	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
85	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
90	95	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
95	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
100	105	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1

* In Vol. LII. Part i. Art. 25. see the First Decade.

There remain alive,

Under ten years of age,		{ Males 126 Females 122 }	248.
From 70 to 75	{ Males 12 Females 21 }	33	{ Males 3 Females 6 }
From 75 to 80	{ Males 8 Females 3 }	11	{ Males 3 Females 5 }
			{ Males 3 Females 6 }
			{ Males 3 Females 5 }

Distempers and Casualties.

Accidents	5	Convulsions	31	Palsy	3
Ague	1	Dropsy	20	Small-pox	46
Apoplexy	5	Drowned	7	Teeth	5
Asthma	3	Evil	4	Untimely	7
Cancer	2	Fever	35	Worms	4
Childbed	4	Jaundice	4	N.B. The remainder died of a natural decay, with- out any distemper.	
Chincough	6	Imposthume	2		
Consumption	101	Meazles	15		

Houses or Families in 1765, 249—in 1770, 240.
 Ditto, paying window-tax, in 1765, 70—in 1770, 65.
 Void houses, none.

Number of persons in 1765,	1096	In the year 1767, nine houses were pulled down, to open a way for building a new stone bridge over the river Severn, by which forty-four persons were removed; six continued in the parish, and thirty-eight went out of the parish.
Ditto, in 1770,	1046	
	Acres.	
In arable and pasture land	1400	
Gardens, yards, and houses	300	
	<hr/> 1700	
There is no waste land.		

VII. *A Letter from Mr. Stephen de Visne to Mathew Maty, M. D. Sec. R. S. containing an account of the manner, in which the Chinese heat their rooms.*

S I R,

Read Jan. 31, 1771. **T**HE great pleasure I have in obliging and rendering any service to your Royal and illustrious Society, made me request the R^{ev}. P. Gramont, missionary, (a man of great family and sense, whom I was acquainted with at Canton before he was ordered to Pekin, by the Emperor) to make enquiries, and collect any curiosity useful to philosophy, mechanicks, and natural history, that might be useful to mankind, and agreeable to the curious. He has been so polite to transmit me the model of a Chinese furnace, used to warm the apartments; together with a muster of different coals, lime, &c. for the Royal Society, which I send to my brother to be transmitted to you; and I shall be happy that it comes safe to your hands. Father Loreyro, missionary and physician to the King of Cochin China (a gentleman we are greatly obliged to for his humanity, in cloathing, feeding, and getting a passage to some poor shipwrecked seamen of the Earl Temple); is at work upon drawing a correct draught

draught of that coast and Cambodia; and I hope, when finished, to obtain one for the Society.

I embrace this opportunity* of also making you an offer of my services, and subscribing myself with the greatest esteem and regard,

Sir,

Your most obedient

humble servant;

Canton,
Oct. 8, 1770.

Step. de Visme.

* Unfortunately this gentleman died at Canton soon after the date of this letter, which deprives the Royal Society, and the public, of the very curious and useful informations they might have expected from him.

VIII. *An Account of the Kang, or Chinese Stoves, by Father Gramont, translated from the French.*

Read Jaa. 31, 1770. **T**HE greatest of all masters is want. It is a spur to genius, gives wings to industry, and points out such resources as neither learning nor curiosity would ever have contrived. This it is which has taught the Chinese to make use of sea coal to warm their houses, and to procure to themselves the benefit of its heat without being annoyed by its offensive smoak. This discovery of the Chinese might perhaps be of use in the great city of London, and those parts of England, where this fuel is burnt in rooms. The warm concern the Royal Society has always shewn for whatever affects the lives or welfare of the community, induces us to hope for a favourable acceptance of a model of the Chinese Kang, which we apprehend may be conducive to those beneficent purposes; we therefore have added such explanations as will give an insight into the theory of it; that it may be made known, and improved upon.

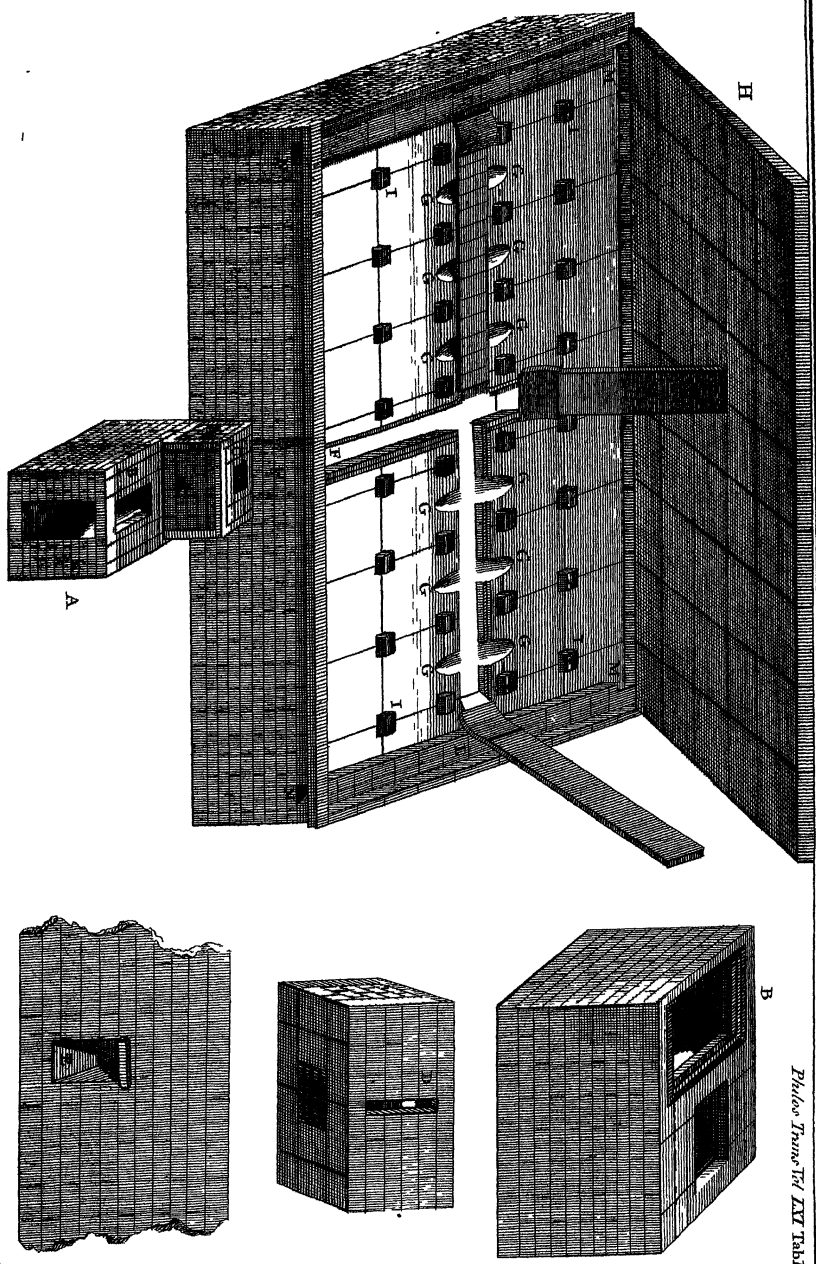
May the illustrious and celebrated Royal Society consider this trifle as a token of our profound respect, and accept it as a small acknowledgement of our gratitude for the favours bestowed upon us, wretched and afflicted as we are! As we have the honour to write to gentlemen eminent for their learning,
we

we shall only relate and describe what is most essential.

1. A Kang is a kind of stove, that is heated by means of a furnace, which casts all its heat into it. Many kinds of stoves, ovens, and furnaces, have indeed been contrived beyond sea, which are somewhat like this; but the Chinese seemed to have found means to unite all their conveniences and uses in the Kang. They are of various sorts, the *Kang* with a pavement, or *Ti-Kang*; the *Kang* for sitting people, or *Koa-Kang*; and the chimney *Kang*, or *Tong-Kang*. As they are all made upon the same principle, we shall confine ourselves to the description of the *Kao-Kang*, from which the model (Tab. iii.) is taken.

The parts of a Kang are, 1. a furnace; 2. a pipe for the heat; 3. a brick stove; 4. two funnels for the smoke.

The furnace is proportioned to the size of the stove it is intended to heat. A is the ash hole. B the cellar. C the furnace. D the slit, or mouth, that conveys the flame and heat into the stove. E The pipe or conductor for the heat. F begins at the mouth of the furnace, and forms a channel which falls in a right angle upon a second, that goes quite through under the middle of the floor; and this last pipe has vent holes, G, here and there. The stove is a pavement made of bricks, H, which being supported at the four corners by little solid piles, I, leaves a hollow space between them and the under pavement, where the heat remains pent up, and warms the floor. The smoke funnels are at both ends of the stove L, with a little opening M upon the



the stove, and another N outward, which carries off the smoke.

Nothing can be more simple than the effect resulting from the assemblage of all these parts. The heat of the furnace, impelled by the outward air, and attracted by the rarefied air of the stove, rushes through the slit, ascends into the tube, spreads through the stove by the vent holes, heats the bricks, and from them the whole room. The smoke, which has a free passage, is carried off by the funnels.

2. Admitting this description, which explains the model; let us next consider what is requisite for the construction of a good Kang. The furnace may be placed either in the room itself, or in the next room, or without doors. The poor, who are glad to make the most of the firing that warms the *Kao-Kang*, on which they sit by day, and sleep by night, place the furnace in the same room; the middling sort put it in an adjoining room; the rich and great have it on the outside, and most commonly behind the north wall. The furnace must be much below the level of the stove, that the heat and flame may ascend with the greater impetuosity into the conductor, and not drive up the ashes. The furnace is in the form of a cone, somewhat arched, that the activity of the heat and flame may be all impelled into the stove, and not fly off when the aperture at the top is left open. Note, that the two little moveable slips are planks, that take up occasionally, when people want to go down into the cellar and empty out the ashes. The opening in the furnace is narrow, and the lower end of the conductor must go quick up into the
stoves

stove. The conductor is to be walled in very close on all sides with bricks, and well cemented with mortar made of quick lime. That which the Chinese use is made with one part of white lime to two of black. The black lime, of which we send a sample, is found at the entrance of the coal pits, and seems to us to be no other than coals dissolved by rain waters. We can attest that this substance mixed with white lime makes excellent mortar, nearly resembling cement. It is proof against rain and sun, and is used here to cover and shelter whatever is exposed to the weather. We should rejoice if this hint could prove useful to the British nation. If their country affords black lime, they are possessed of a great treasure.

The ground or flooring of the stove may be of beaten clay, or, what is infinitely better, bricks placed edgewise, or large paving tiles.

The funnel for the smoke; or rather the two funnels, must be made with great care. Some make them terminate in little chimneys, that carry off the smoke above the roof. In the model, they open into the room, as the city poor have them; but in the country, and in gentlemen's houses, they are on the outside.

It is of consequence that the little piles which support the great square bricks of the floor be very solid, and the bricks very thick and perfectly square. The Chinese bind them with a sort of cement made of white and black lime, tempered with *Tong Yeou*, which is a kind of varnish. We are apt to think walnut or linseed oil boiled would do as well.

As

As soon as the Kang is compleated, fire is kindled in the furnace, to dry it quick and even. Great diligence must be used in examining it, in order to stop up all the little holes through which the smoke might escape. The wealthy, to make their Kang neater, and to moderate its heat, oil the bricks of the floor, and light the fire, to make the oil penetrate deeper, and to dry them the faster. This oil is again the *Tong Yeou*, and may be supplied with walnut oil.

3. The *Ti Kang*, or paved Kang, is made like the *Kao Kang* just described; the only difference is, 1°, The pipe for the heat goes on rising from the mouth of the furnace to the further end of the room. 2°, It does not communicate with a second pipe, as in the model. 3°, The vent holes that convey the heat into the stove are all made narrow next the furnace, and go widening towards the stove. 4°, The funnels for the smoke always terminate without doors, or end in the little chimneys. 5°, In the Emperor's palace and those of princes, the stove is covered with two rows of bricks, to confine the smoke, and to moderate the heat.

Note, That the bricks in the royal apartments are two feet square, and four inches thick. They cost near a hundred crowns apiece; and are so beautiful, good and solid, that you can have no conception of any such thing beyond the seas. They are grey; but this is owing to the Chinese manner of baking their bricks and tiles, which comes nearer to that of the antients than ours. These bricks when coloured and glazed appear as fine as marble. The

Tong-Kang, or the *Kang* built in the wall, differ from the *Ti-Kang* only by its perpendicular position; the theory is the same.

4. The *Kang* is heated by lighting a fire in the furnace. The smoke and even the flame rushes violently into the pipe, and is carried off by the vent holes all through the stove, where, being pent up, it heats the bricks of the pavement in the space of five or six hours: when a *Kang* is thoroughly heated, very little fire is required to keep it warm, though here the thermometer is almost all the winter at 9, 10, and even 12 or 13 degrees below the freezing point (in Reaumur's thermometer); and although all the rooms are on the ground floor, and have nothing but windows, and those paper windows, all over the front, which is commonly to the south, the warmth of the *Kang* is sufficient to keep up their temperature at 7 or 8 degrees above frost, with very little fire constantly kept up. It seldom rises to more than 4 or 5 degrees in the Emperor's apartments, owing to the double row of bricks, but the warmth is very gentle and very penetrating.

As a *Kang* is heated by a furnace, any kind of fuel will do, *viz.* wood, charcoal, sea coal, furze, &c. The Chinese make the most of every thing. In the palace they burn nothing but wood, or a kind of coal which neither smoaks nor smells, and burns like tinder. The generality of people burn sea coal: the poor in the country make use of furze, straw, cow dung, &c.

A great saving may accrue from the following observation; the Chinese, to save coals, pound them to
the

the size of coarse gravel, and mix them with one third, or even an equal quantity, of good yellow clay. This mixture being well kneaden, they make it up into bricks, which strike a greater heat than wood, and come incomparably cheaper. The sea coal thus tempered is far less offensive; and besides, the Chinese, in order to draw off the noisom vapours of the air, constantly heated by the coal fire, always keep bowls of water in the rooms, and renew them now and then. The gold fishes that are kept in these bowls are both an ornament and amusement. In the palace, the Emperor's apartments are decorated with flower pots, and little orange trees, &c. The Chinese philosophers pretend that this is the best way to sweeten the air, and absorb the fiery particles dispersed in it. They likewise leave two panes open night and day at the top of each window, to renew the air, which they think is too much rarefied by the heat. These particulars may appear too trifling to be laid before the Royal Society; but, as they relate to the preservation of their fellow citizens, we hope the worthy members will make allowances in favour of the motive.

5. The Kang is attended with many advantages and conveniencies. 1°, The rich and great are not exposed to the troublesome attendance on a fire in the chimney, and enjoy all its benefits. 2°, The poor use all sorts of fuel without any other expence than what the kitchen requires, and have the comfort of sitting warm by day, and lying warm by night. The fire in the furnace serves to dress victuals, and to heat the stove. The poor go further still: they enclose within the brick work of the Kang a vessel, either

of copper tinned, or of iron, which supplies them with hot water for their tea. This water evaporates in the night, moistens the air of the room, and absorbs the noxious particles of the sea coal. We cannot forbear dwelling upon these little æconomical observations, as our aim is public utility. The Chinese are wont to say, The Emperor can build a palace, and cannot make a shrub; one word from his mouth makes a nobleman of a mere citizen, but all his wishes and prayers cannot prolong the lives of his favourites one single moment.

It is not our part to point out what use might be made of the Chinese Kang beyond the seas; but we apprehend that the *Ti-Kang* might be a profitable improvement for hospitals, manufactories, &c. and a pleasing one for the rich. The *Tong-Kang* properly managed would do very well in upper rooms, and would afford warmth for the bed-chamber, and fire for the dressing-room. The *Kao-Kang* seems less adapted to the customs and manners of Europe, but industry might find some use for it in the country. Should the Kang be rejected on account of its novelty, some hints might still be taken from its construction for the use of several kinds of handicraft.

The Chinese sea coal may give some insight into the formation, qualities, uses, and nature of this singular fossil; but this would require a separate paper. All we shall here observe is, that, as far as we can judge from the samples we have seen, it seems for the most part to be a stone dissolved by the waters, and impregnated with sulphur. Its hurtful qualities proceed from a mixture of antimony, copper, iron, &c.

&c. The best coal, and that which burns fiercest, is glossy, hard, and brittle. The Chinese are very fond of that sort that flies, and snaps in the fire, to burn in their forges, because it contains a great deal of salt-petre. When the flame is blue, it is very fierce, but it is too dangerous, as the sulphur is too predominant.

Peking, 22 Oct. 1769.

P. S. If we have expressed ourselves improperly, which would not be very surprizing, considering how little we are versed in these matters, and how little time we can spare for Europe, we are ready to retract whatever may be thought amiss, and to give what further informations may at any time be desired. Whoever has so loved the Chinese for Christ's sake as to come and seek them in this far country, has not divested himself of his attachment to Europe, and will ever be solicitous for the welfare of those he has left behind, and endeavour to promote it, both by their prayers, and imparting whatever may conduce to alleviate the miseries of this short life.

In what a striking light do we here see the vanity of the world, the intoxication of philosophy, and the wretchedness of those who know nothing of Jesus Christ! Learning, vice, and idolatry, go hand in hand in the sanctuary of policy; which knows nothing but the Creator of the world, whom the Chinese worship on their knees, and dishonour in their lives.

As there is room left in the box that contains the model, we have put in some little specimens of sea coal.

N° A. 1, 2, 3, different sorts of sea coal, or rather stones dissolved, and turned to coals.

N° B. 1, 2, sea coal, such as is burnt here. N°. 2 is the best. N° 3. is the same coal turned to black lime. This you may be convinced of, by dissolving it in water, and mixing it with white lime.

N° C. 1, 2, 3, 4, several degrees of bad coal, which produces a dangerous smoke that occasions fainting fits. N° 4. is the worst, and is laid by for the use of forges, whenever it is found.

N° D. is a kind of Clinker, extracted from the ashes of sea coal. That which produces the greatest quantity of it is reckoned the best.

If the Society should be desirous of further informations concerning the sea coal, we must beg to be favoured with particular questions; but let it be remembered, that we are not within reach of such helps as chemistry would afford, nor can elucidate the matter by experiments.

IX. *Account of a remarkable Thunder Storm :
In a Letter from the Rev. Anthony Wil-
liams, Rector of St. Keverne, in Corn-
wal, to the Rev. William Borlase, D.D.
F. R. S.*

DEAR SIR,

Keverne, Aug. 27, 1770.

Read Feb. 7, 1771. **I** HAVE received yours, which, I must confess, I ought to have answered much sooner.

For several days before the thunder storm which fell on St. Keverne spire and church, on Sunday the 18th day of February last, the wind was very hard at North and North West, accompanied with violent showers of hail, which had done some damage to the roof of the church, and many houses in the church-town. On the Sunday morning above-mentioned, the wind being at North-west, from five o'clock during almost the whole day the wind was excessive hard; and about six, I saw some few faint flashes of lightning, which, as the day came on, if it continued, became imperceptible. The weather being so bad, prevented a great number of people from coming to church, which in all human probability was a happy circumstance; for, about a quarter.

quarter after a eleven o'clock, while I was in the latter end of the Litany service, we had a very fierce flash of lightning, followed at the distance of about four or five seconds by the loudest thunder I remember ever to have heard; but which did no damage, nor seemed in the least to disturb any of the congregation, though at the same time the roof of the church was rising, and the hail made a noise terrible to be heard. In half a minute after this, as near as I can possibly guess, the whole congregation, except five or six persons, were at once struck out of their senses. I myself received the thock so suddenly as not to remember I either heard the thunder or saw the lightning: the first thing that I can recollect with any degree of certainty is, that I found myself in the vicarage seat, which is very near the desk, without either gown or surplice, bearing in my arms as I then thought a dead sister, and God knows it was a miracle that she was not so; I perceived a very strong sulphureous smell, almost suffocating, and a great heat. At this time the confusion among the congregation was inconceivable, some running out of the church for safety, and returning into it again (for the stones from the roof were falling on our heads, both in and out of the church); some on their knees, imploring the divine assistance, giving themselves up to certain destruction; and a great many, in different places of the church, lying quite motionless, whom I thought then to be quite dead.

In the afternoon, my thoughts being a little composed (I believe for full two hours I could not be said to be rightly in my senses), I walked to the church, to see what damage was done; and such a scene

scene presented, as is horrible to think of, much more to see. The church-yard was almost full of ruins; the spire, which was about forty-eight feet high from the battlements of the tower, was carried off half way down, and the remaining part cracked in four places very irregularly down to the bottom. The north side of the tower from the battlements to the arch of the bell chamber window was quite out, except the corner stones, which remained firm and unremoved; the lead on the top of the tower was greatly damaged, melted in several places, and as it were rolled together. The arch of the belfry door, which was very strongly built with a remarkable hard iron stone, laid in lead, was also greatly damaged; some of the stones were cracked cross-ways, and just removed out of their places, others were quite hove out, and the lead between the joints not only melted, but loosened so as that you might pick it out with your fingers. The traces of the lightning were here discovered along the surface of the earth; the stones were thrown from the spire on the tops of many houses in the Church Town, but did no great hurt; in a gentleman's house, one stone weighing fourteen pounds fell through the roof into the chamber, but did no further hurt than to make a hole in the roof and plastering. It is to be observed, that the stones from the spire were scattered in all directions, as well against the wind as with it, some of which, but not very large, were found but a little short of a quarter of a mile. The spire from the top six feet downwards was solid, through which passed an iron spill to fix the weather-cock on. Did not the lightning first strike on this spill, and was conducted

through the solid part of the spire, and, having not iron to conduct it any further, burst in the hollow part of the spire, and threw the stones about in all directions? It is remarkable that the spill was found in the bell-chamber, and the weather-cock in the battlements; and that the bells were not in the least damaged, though a deal board, that lay across the beams to which the bells were hung, was split long ways in two pieces. The inside of the church still presented a much more horrible spectacle; the roof of the church was almost all gone, and some of the timber work in the north isle shattered to pieces; every seat in the church had rubbish in it, some more some less, and stones of large size, some of 150 pounds weight and upwards, scattered here and there amidst the congregation, which damaged the seats, &c. but did no hurt to the people, though they sat in those very seats where the stones fell. The lightning entered at the three ends of the church at West, made its way through the body of the church, and went out through the three ends of the church at East; the holes where it came in and where it went out are not large, neither are the walls much damaged. The belfry window was shattered to pieces, not one whole pane I believe to be found in it; many other windows also suffered greatly, the glass and munnions being much shattered. The lightning entered also through two places in the roof, one near the singing loft, and struck upon the top of a pillar just by it; the traces of it are to be seen from the top of the pillar almost to the bottom: there were then sitting by this pillar two young men, one in the singing loft, and other under him in the church, who were

were both lightly scorched ; he in the loft from head to foot, and the other in the face only : but it is remarkable that his hat, which hung on a nail just above him, was cut in two pieces. In the other place, the lightning entered just over the desk and pulpit, and fell in like manner on a pillar that stands in the vicarage seat ; but here it was a great deal more violent, and, as the object of its fury was my sister, I hope you will excuse my being very particular. Upon this pillar rested a large oak soil, the bottom of which was burst into six pieces, and one of the pieces, being a very large one, was thrown from its place to the distance of about 20 feet, and appeared to be burnt, the other pieces did not fall. From thence the lightning came down the pillar with great force, tore the seat into many pieces, knocked down my sister, and made its way through the bottom of the seat into the earth. She had pattens on, and the wooden part of one of them was broke into three pieces ; the holes, through which the ribbon is put to tie them together, were quite burnt out, and the ribbon found in the seat without the least damage, or so much as the knot loosened ; her shoe was burnt, and rent from the toe to the buckle ; but the buckle, which was of silver, remained unhurt ; her stocking was burnt and rent in the foot, just in the same manner as her shoe, and scorched along to the garter, and two little holes were burnt through in the leg of it : her apron, petticoats, &c. were burnt through and through, and she had several slight burns on several parts of her body, besides two bruises on her head and breast, caused by the rubbish that fell into the seat. As she was carrying out of church, she

greatly complained of a deadness in her legs, which, as she could not move them at all, I supposed were broke; however, they were not broke, only a little burnt, and turned as black as ink; which, by timely care, not only came to their natural colour by Tuesday noon, but could support her also to come down stairs; and, excepting a hurry of spirits, grew quite well that week.

Not more than ten persons out of the whole congregation were hurt, and none of them to any great degree; one young fellow, who was more frightened than hurt, remained ill a long time, but I believe he is now quite well; the lightning touched his watch in his pocket, the marks of which may be seen on the crystal and silver part of it to this day. Nobody remembers to have heard any more thunder, or seen any more lightning after this, though the weather continued very stormy all that day; so that this thunder storm, from beginning to end, could last but a very short time. The damage we suffer by it (which is now repairing) will amount to about 450 l.

Thus, Sir, I have given you a particular account of this dreadful accident, by which a great number of people, had it not been for the favourable, I may say, miraculous interposition of Providence, must inevitably have perished. It must really excite our wonder to consider that not only not one life was lost, but that no person was hurt to such a degree as to confine him for more than two or three days.

I remember to have seen an observation of yours: "How deplorable would be the consequences of such
" blasts of lightning, if they happened where are
" large

“ large congregations in time of divine service!” Here you see, Sir, they have happened under the very circumstances in which you then thought they must prove fatal. But Providence has let us know, in this remarkable case, that, let the danger be ever so great, and seemingly to us unavoidable, yet he is willing, as well as able, to save us.

I am, dear Sir,

Your most obedient,

humble servant,

Anth. Williams.

X. *Explication of an inedited Coin, with two Legends, in different Languages, on the Reverse. In a Letter to Mathew Maty, M. D. Sec. R. S. from the Rev. John Swinton, B. D. F. R. S. Custos Archivorum of the University of Oxford, Member of the Academy degli Apatisti at Florence, and of the Etruscan Academy of Cortona in Tuscany.*

GOOD SIR,

Read Feb. 7,
1771.

THE coin I shall here attempt to explain on one side (See TAB. III. n. 1.) presents to our view the head of Jupiter, and on the other the prow of a ship, which indicates the place wherein it was struck to have been a maritime town. Above the prow of the ship, we see two characters, that are either Punic (1) or Phœnician. I say, either Punic or Phœnician, because it may not perhaps be so easy to determine whether that town was occupied by the

(1) From the present state of the Kabyles we may infer, that the ancient Africans, or Indigenæ, their progenitors, must have been a very rude uncivilized people, at the first arrival of the Carthaginians amongst them. It is therefore utterly improbable, that they ever used any alphabetical characters, before the Phœnician letters were introduced into their country by the Carthaginians; or that any other characters, peculiar to themselves, and different from the Punic, ever afterwards prevailed amongst them. I cannot therefore but think, that those learned men who suppose the reality of such characters are egregiously mistaken, as they can have nothing to advance in support of such an opinion. Shaw, *Travels, &c.* p. 288, 289, Oxford, 1738. Peller. *Suppl. quatr. & dern.* p. 55. A Paris, 1767.

Cartha-

Carthaginians, or the Phœnicians, and the Romans, when the piece first appeared. Besides the two above-mentioned characters, there is a monogram, formed of the three Latin letters V, A, B, very indifferently preserved, in the exergue, with which the Punic or Phœnician elements perfectly correspond. For the second of those elements is manifestly the most common Punic or Phœnician form of *Beth*, and I have many years since proved the first (2) to be a form of the Phœnician and Samaritan *Vau*; and (3) observed, that though it sometimes answers to V consonant, it is likewise not seldom taken for *Beth*, or B. Nor is this to be wondered at, as those two letters so nearly in power approach one another. The middle element of the monogram, A, has nothing equivalent to it in the Punic or Phœnician inscription; that vowel, in conformity to the genius of the oriental orthography, between the two consonants, being there suppressed. But the two Punic or Phœnician characters, and the Latin monogram, clearly enough demonstrate the name of the town where the piece was struck. The monogram seems to be preceded by a sort of date in the exergue, which resembles the characters [CXI; but, as these characters are ill preserved and indistinct, I believe the powers of them will not be so easily ascertained.

From what has been here laid down, the learned will easily admit the medal in question to have been struck at Vabar, a maritime city of Mauritania *Cæsariensis*, after that place had been ceded to the Romans, and was inhabited by them, and either the Carthaginians or the Phœnicians. Vabars I mention-

(2) *De Num. quibusd. Sam. et Phœn. &c. Dissert. p. 73, 74.*
Oxon. 1750. (3) *Ibid. p. 74.*

ed by (4) Ptolemy, but in his days seems to have been a place of no considerable note. It, however, probably made a greater figure, when inhabited either by the Carthaginians, or the Phœnicians, and the Romans; for that it was occupied by two at least of those nations, when the medal before me first appeared, the legends on the reverse, though somewhat imperfect, render sufficiently clear. That the Carthaginians were possessed of this city in ancient times, is consonant to the faith of history; since they were masters of all that part of Africa extending from the pillars of Hercules, or streights of Gibraltar, to the greater Syrtis, for a considerable period of time, as we learn from (5) Polybius. And that the Phœnicians were masters of it in early times, is equally probable. For that they occupied the sea-coast of Mauritania, from at least the generation immediately preceding Homer to the time it fell into the hands of the Romans, we are informed by Strabo (6). It cannot therefore be easily determined, as already observed, whether the piece in question was struck by the Phœnicians or the Carthaginians. It must, however, be attributed to the town of Vabar, when inhabited by either the Carthaginians or the Phœnicians, not improbably the latter, and the Romans; the two legends on the reverse, as well as the perfect agreement between them, rendering this incontestably clear.

That the piece I am considering was either of a Punic or an Africo-Phœnician origin, may be deemed probable from hence, that it exhibits a Latin legend

(4) Ptol. *Geogr.* Lib. IV. c. ii.

(5) Polyb. *Megalopolit. Historiar.* Lib. iii. p. 266, 267. Amsterdam, 1670.

(6) Strab. *Geogr.* Lib. iii. p. 150, 151. Lutetiae Parisiorum, 1620.
on

on the reverse, as do several other Punic or Africo-Phœnician coins. This appears from some of the medals of the elder Juba, one of Achola, and another of Leptis, now in my small collection; to omit other similar instances, that might, with great facility, be produced: whereas, unless I am greatly deceived, none of the Asiatico-Phœnician coins have ever yet presented to our view any Latin characters. This is an additional proof in support of what has been here advanced; and seems farther to evince, that my medal must be assigned to the town of Vabar, and was struck there; when that place was occupied by either the Carthaginians or the African Phœnicians; and the Romans; though the time of that operation cannot, with any tolerable precision, be ascertained.

I shall only beg leave to add, that though Vabar was a place of no great note in the days of Ptolemy, it seems to have been a town of some consideration in the earlier times, as (7) Dr. Shaw saw some ancient ruins on the spot where it formerly stood; that a coin of this ancient city has never yet, I believe, been communicated to the learned world; that the medal before me, which at present has a place in my small cabinet, is one of those very few Punic or Phœnician coins that are adorned with a Latin legend, and consequently merits the particular attention both of the curious and the learned; and that I am, with the highest regard,

S I R, Your much obliged

and most obedient humble servant,

Christ-Church, Oxon.

Sept. 28, 1770.

John Swinton.

(7) Shaw, ubi sup. p. 89. Oxford, 1738.

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M

XI. Remarks

XI. *Remarks upon Two Etruscan Weights, or Coins, never before published. In a Letter to Mathew Maty, M. D. Sec. R. S. from the Rev. John Swinton, B. D. F. R. S. Custos Archivorum of the University of Oxford, Member of the Academy degli Apatisti at Florence, and of the Etruscan Academy of Cortona in Tuscany.*

GOOD SIR,

I.

Read Feb. 7, 1771. **T**HE first piece to be considered here is an Etruscan as, (See TAB. III. n. 2.) or weight, exhibiting on one side the head of Janus, covered with a cap; and on the reverse a club, attended by the mark of the As, and the legend **140A-JE 2** in Etruscan characters. Between the two faces of Janus, the head of a bufolo, or wild ox, presents itself to our view, as does also a sort of concha marina, or sea-shell, somewhat resembling one on a didrachm of Tarentum, in my small cabinet, and several other ancient coins, contiguous to the cap; both of which have, not a little, suffered from the injuries of time. The letters on the reverse are
more

more rude and barbarous than those of any similar Etruscan coins hitherto published, which is an incontestable proof of the exceeding high antiquity of this piece. The forms of several of them are likewise somewhat different from those of the correspondent elements on all the other similar Etruscan weights, hitherto communicated to the learned world. The concha marina, and perhaps the bufolo's head, is a singularity that will announce the weight before me an inedited coin. The piece weighs precisely five ounces, and twelve grains; and is, in all respects, except what relates to the concha and bufolo's head, tolerably well preserved.

The first riches of mankind were their flocks and their herds, and particularly their (1) oxen. Hence the first money in Italy, from pecus, was (2) called pecunia, and the most ancient brass coins had the figure of an ox (3) impressed upon them. Hence also the Greeks, in the days of Homer (4), estimated the value of their properties according to the number of oxen they were equivalent to, as we learn from that celebrated poet. For he informs us, that Glaucus's golden armour was worth an hundred oxen, whereas that of Diomedes, for which it was

(1) Erasmi Frölich. *Notit. Elementar. Numism. Antiquor. &c.* p. 2. Viennæ, Prægæ, & Tergesti, 1758.

(2) Plin. *Nat. Hist.* Lib. xviii. p. 98. l. 6, 7. & Lib. xxxiii. p. 610. l. 6, 7. Ed. Hard, Parisiis, 1723. Fröl. ubi sup. et alibi: *Una lettera del Annib. degli Abati Olivieri al Sig. Abate Barthelamy, &c.* p. 28, 29. In Pesaro, 1757. Ezech. Spanhem. *De Us. et Præstant. Numismat. Antiquor. Dissert. prim.* p. 23. Londini, 1706.

(3) *Idem* ibid.

(4) Hom. *Il.* z. 235, 236, 237. Vid. etiam Eustath. in loc.

exchanged, did not exceed the value of nine of those animals. The figure of the ox on the most ancient money seems to have been soon converted in Etruria into the symbol of the head of that beast connected with the head of Janus, who is (5) said to have first introduced the use of money into Italy. The head of the *bufolo*, or wild ox, may, as I conceive, have appeared on some of the most ancient coins of Tuscany, and particularly the piece I am at present considering, because the *bufolo* was formerly, and is still, a native of that country. When I resided there, above thirty years since, the woods between Leghorn and Pisa abounded with them. They were then likewise said to have been very numerous in other parts of Tuscany, and La Romagna, and several of them, at different times, both tamed and wild, I myself have there seen. The reason here mentioned seems to extend to other remains of antiquity of the Etruscans besides their coins, on which the head of the *bufolo* appears, as the (6) authors here referred to have rendered sufficiently clear.

From what has been observed, as well as from the thickness, high relief, and extreme rudeness of the workmanship, or rather in conjunction with these, we may conclude, that our *As* is either coeval with some

(5) Cytherius Post. apud Athen. *Deipnosoph.* Lib. xv.

(6) Anton. Francisc. Gor. *Mus. Etrusc.* Tab. CXXIII. Hamilton's *Collect. of Etrusc. Greek, and Rom. Antiqu.* Vol. II. pl. 63. I have a fine Etruscan *Vas Potorium*, (See Tab. III. n. 3.) ending in a *bufolo's* head; which, as I apprehend, formerly belonged to Cardinal Gualtieri: as also another, terminating in (See Tab. III. n. 4.) the head of a gray-hound, similar to one published by Mr. Hamilton, which had likewise a place assigned it in the Cardinal's collection of Etruscan antiquities. I bought both of them of Sig. Barazzi, at Rome, in 1733. Hamilton's *Collect. of Etrusc. Greek, and Rom. Antiquit.* Vol. I. pl. 49.

of the earliest pieces, or weights, ever used in Italy, or but little posterior to them. Father Gori (7) seems to be of the same sentiments with me, in this particular; and neither Sig. (8) Olivieri, nor any other writer, has invalidated, or disproved, what has been advanced on this head, by that celebrated author.

That the weight here considered is to be assigned to a maritime town, the *concha marina*, or sea-shell, irrefragably proves. I should therefore, with the very learned Sig. Olivieri, rather attribute it to Volterra, than to Velitræ (9), at present called Velletri, as Father Gori (10) seems to have done. For Velitræ was a town of Latium, and much less considerable than the city of Volterra; which (11) was the most ancient city of Etruria, the seat of a *lucumo*, and one of the most considerable places in Tuscany. It was also a maritime city (12).

(7) Anton. Francisc. Gor. *Mus. Etrusc.* Vol. II. p. 419. et alib. Florentiæ, 1737.

(8) Sig. Oliver. *Una Lettera, &c.* In Pesaro, 1757.

(9) Annib. degli Abati Olivieri, in *Esame della Controversia Letteraria, sopra il Museo Etrusco, stampato negli Opuscoli scientifici*, Tom. XXI. et ubi sup. p. 43. The old Etruscan word VELATRI, FELATRI, or FELATERI, seems to have been tolerably well preserved in the name of Monte Veltrajo, or Feltraio, a mountain in the territory of Volterra, and about two miles from that city. This, as I apprehend, may be considered as an additional argument in support of Sig. Olivieri's and Monsignore Mario Guarnacci's opinion. *Notizie storiche della città di Volterra, opere del Sig. Lorenz. Aul. Cecin. dal Caval. Flamin.* Dal Borgo, p. 44, 49. In Pisa, 1758. Monsig. Mar. Guarnacci, in *Origin. Italich.* In Lucca, 1767.

(10) Anton. Francisc. Gor. *Mus. Etrusc.* Vol. II. p. 427.

(11) Christ ph. Cellar. *Geogr. Ant.* Lib. II. c. ix. sect. 2. p. 573, 574. Lipsiæ, 1731. Vid. etiam Tho. Dempst. *De Etrur. Regal.* et Anton. Francisc. Gor. *Mus. Etrusc.* passim.

(12) Strab. Lib. V. p. 223. Lutetiæ Parisiorum, 1670.

as we learn from Strabo, being seated not far from the Vada Volaterrana, near the place where the river Cæcina threw itself into the Tyrrhenian sea. I would therefore read the legend, on the reverse of this coin, FELATHERI, FELATERI, or FELATERRI; the fifth letter being (13) sometimes endued with the power of *Theta*, and sometimes with that of *Tau*; and a duplication of consonants, in writing, having been unknown to the most ancient Etruscans. That the vowel E, between the fifth and sixth elements of the Tuscan legend, on the reverse hereon, should be suppressed, or omitted, will not be any matter of surprize to those who are apprized, that such a suppression, or omission, so consonant to the genius of the Hebrew and Phœnician orthography, from which that of the most (14) ancient Etruscans could not have greatly differed, in old Tuscan words, does not seldom (15) occur. Of this MENLE, HERCLE, MELACRE, PHVLNICE, MENREA, which were read MENELE, or MENELAE, HERCVLE, MELEACRE, PHVLVNICE, MENEREA, or MENEREA (16), are convincing proofs; to omit many other similar instances, that might, with great facility, be produced. But this is so settled a point, that it

(13) Anton. Francisc. *Gor. Mus. Etrusc.* Vol. II. p. 408, 409.


(14) Swint. *De Lingua Etrur. Regal. Vernac. Dissertat.* Oxon. 1738.

(15) Phil. Bonarot. Tho. Dempst. et Anton. Francisc. *Gor. uli sup. pass.* Vid. etiam Joan. Bapt. Passer. Pisaurens. *Hellenism. Etruscor. in Symbol. Litterar. &c.* Vol. II. p. 35—73. Florentiæ, 1748, & Carlo Antonioli in *Antic. Gem. Etrusc. spiegat. & illustrat. &c.* p. 70—78. In Pisa, 1757.

(16) *Iidem ibid.*

will not be contested in any part of the learned world.

II.

The second piece, or weight, of which I propose to give an account in this paper, is a stips uncialis, (See TAB. III. n. 5.) as appears both from the weight and size of it, of the earliest date. I received it, as a present, from my worthy friend James Gilpin, Esq; late recorder of the city of Oxford, with several other ancient brads coins. On one side it has preserved the head, or rather a full face, of the * sun; the workmanship of which is more rude and barbarous than that of any other similar piece that ever fell under my view; and done perfectly in the most ancient Etruscan taste. The reverse had originally on it the prow of a ship, which has been so totally effaced by the injuries of time, that only a very few exceeding faint traces of it are now to be seen. The relief on the face-side is very high, as was undoubtedly at first that on the other; but the reverse being in a manner quite smoothed, nothing there remains but the vestiges of the prow of a ship, that are barely visible. However, just over the prow, we may discover clearly enough the legend  in Etruscan characters, though but very indifferently preserved. That

* We meet with a full face of the sun pretty much resembling this on a denarius of the Plautian family, but done in a much more elegant taste; which demonstrates it to be vastly inferior, in point of antiquity, to the piece I am now offering my thoughts upon. Sig. Havercamp. *Thesaur. Morol.* Tom. II. p. 329. Amstelredami, 1734.

word is apparently equivalent to ROMA, and consequently the piece itself must be deemed an uncia, or stips uncialis, of Rome, though the globule, or uncial mark, has not escaped the ravages of time.

That the piece in question is an uncia of Rome, appears not only from the legend on the reverse, as just observed, but likewise from another uncia of Rome, with the full face of the sun upon it, as here, though done in the more modern Roman taste, now in my small collection. That uncia is likewise, I doubt not, in several (17) other collections; being, as I apprehend, a pretty common coin. The same conclusion is likewise deducible from another Roman uncia, with the word ROMA, just above (See TAB. III. n. 6.) the prow of the ship, on the reverse, in the very same situation as the Etruscan legend on the weight before me, in my little cabinet. We may therefore safely enough pronounce the coin here described a stips uncialis of Rome, of a very remote antiquity, with the Etruscan name of that capital of the world on the reverse.

The Etruscan letters were, undoubtedly, the first alphabetic characters of Italy. Nay, they prevailed at Rome, and in every part of Italy, till after the refugee. This I have fully proved in a Latin (18)

(17) Scipionis Maffei *Origin. Etrusc. & Latin.* p. 61. Tab. II. Ord. II. n. ii. Lipsiæ, 1731. Annib. degli Abati Olivieri in *Indice Delle Antichiss. Monete di Bronzo Romane & Italiane.* ubi sup. p. 53. In Pefaro, 1757. See Haverc. in *Rom. Tab.* III. n. 4.

(18) *De Præcis Romanorum Literis Dissertat.* Oxon. 1746. Many curious particulars are deducible from the point here insisted upon. To omit others that occur, from hence it plainly follows, that those inscriptions on the Eugubian tables consisting of Latin letters, or the more modern characters of Italy, are
dissertation,

dissertation, printed at Oxford, in 1746. The piece at present engaging my attention is an additional, or rather an apodictical, proof of the truth of what was there advanced. It demonstrates the Etruscan letters to have been used at Rome, in very early times; and consequently evinces, in the strongest manner, the principal point insisted upon in that dissertation.

The time when the medal I have been considering first appeared, for want of proper chronological characters, and sufficient light from history, cannot, with any precision, be ascertained. But, from a perusal of the small performance (19) above-mentioned, and what has been offered here, we shall, I believe, be induced to conclude, that it is at least coeval with the regifuge, which happened in the year of Rome 245; or rather, as I should apprehend, that it may be a considerable number of years anterior to that event.

The two brass coins above described being extremely curious, especially the second of them, an Etruscan coin of Rome having never been heard of before; and many curious points being deducible

more recent than the regifuge. Nay, in the dissertation here referred to, they have been demonstrated inferior, in point of antiquity, to the Duilian inscription; and consequently Father Gori must be egregiously mistaken, when he makes all the inscriptions on those tables some generations older than the Trojan war. See the *Universal History*, Vol. XVI. p. 48. Lond. 1748.

It may not be improper to remark here, that the Etruscans had not the letter O in their alphabet, but constantly made use of V for that element. Hence it came to pass, that the Etruscan name of Rome was not Roma, but Ruma, as it appears on my very ancient coin. *Philosoph. Transact.* Vol. LVIII. p. 256.

(19) *De Præf. Romanor. Lit. Dissertat.* p. 6, 7, 8, 9, 10. Oxon. 1746.

from that coin, which I have not time at present even to touch upon ; I was willing to flatter myself, that the short account of them, in this paper, would not be unacceptable to the Royal Society. I have therefore taken the liberty to transmit it to you, in order to its being laid before that very learned and most illustrious body ; and am, with great truth,

Good Sir,

Your much obliged,

and most obedient, humble servant,

Christ-Church, Oxon.
Sept. 29, 1770.

John Swinton.

XII. *Interpretation of Two Punic Inscriptions, on the Reverses of two Siculo-Punic Coins, published by the Prince di Torremuzza, and never hitherto explained. In a Letter to M. Maty, M. D. Sec. R. S. from the Rev. John Swinton, B. D. F. R. S. Custos Archivorum of the University of Oxford, Member of the Academy degli Apatisti at Florence, and of the Etruscan Academy of Cortona in Tuscany.*

DEAR SIR,

Read April 11, 1771. **T**HE two Punic legends, of which I am now to attempt an interpretation, have been published, together with five others, by the Prince (1) di Torremuzza, in his volume of ancient inscriptions, printed at Palermo, in 1769. As the coins, on which they have been preserved, seem extremely curious, and are unnoticed by any other author; the Royal Society will indulge me the liberty of transmitting them my sentiments of those very valuable remains of antiquity, in this paper, drawn up in the shortest and most concise manner possible.

(1) *Sicil. et adjacent. insular. veter. inscript. nov. collect. Sc. class. XX. p. 292, 293. Panormi, 1769.*

I.

The first of these minute inscriptions, (See TAB. III. n. 7.) which is the first of those published (2) by the Prince di Torremuzza, in the place here referred to, adorns a fine Punic tetradrachm, as it should seem, well enough preserved; which on one side presents to our view the head of a woman, and three fishes; but, on the reverse, the head of an horse, behind which stands a palm tree, attended by an inscription, in the exergue, formed of seven Punic letters. The workmanship, as well as the types, is probably similar to that of the silver medals of Menæ, by me described and explained, in (3) one of my former papers.

The first of the letters, of which this inscription is composed, will be allowed an *Ain* of the usual Punic form. This may be collected from the (4) coins of Menæ, just mentioned, as well as others, that might easily be produced. The second seems to be *Nun*. But it has been inaccurately taken, and is in reality *Mem*. This is likewise clearly evinced by the (5) legends on the reverses of other similar Siculo-Punic coins. The third is undoubtedly the Punic

(2) Ibid. p. 292.

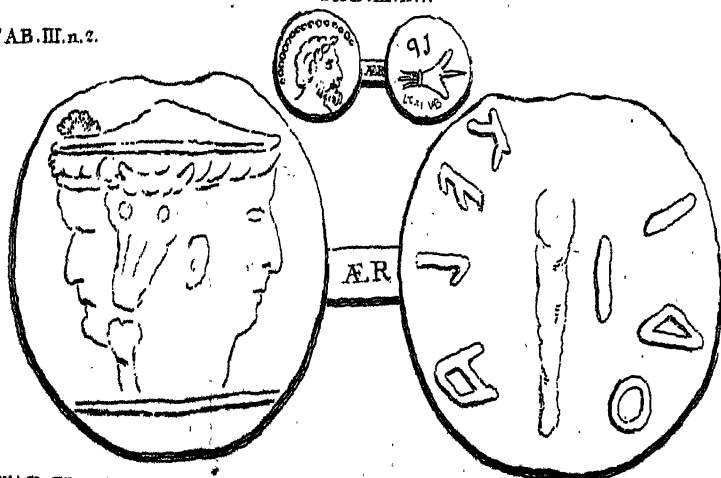
(3) *Philosoph. Transact.* Vol. LIV. Tab. xl. n. 1. p. 99, 404.

(4) *Philosoph. Transact.* ubi sup.

(5) *Philosoph. Transact.* ubi sup. D. Bernard. Aldret. *Var. Antiquedad. de Espan.* &c. p. 177—180. D. Vincen. Juan de Llanos. *Mus. de las Medas. desconocid. Español.* Tab. 45. En Huesca, 1645. Peller. *Recueil de Medaill.* &c. Tom. Trois. p. 22. pl. 88. n. 5. A Paris, 1763. *Memoir. de Litterat. de l'Academ. des Inscript. & Bell. Lettr.* &c. Tom. Trentiem. p. 417. pl. ii. n. 8, 9, 10, 12. A Paris, 1764.

TAB. III. n. 7.

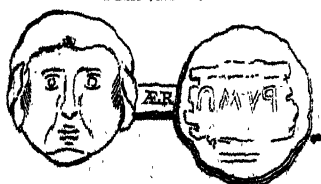
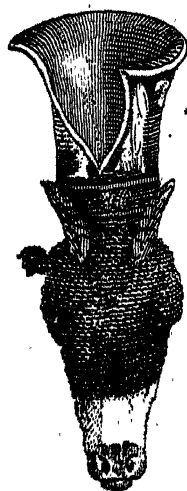
TAB. III. n. 2.



TAB. III. n. 3.

TAB. III. n. 5.

TAB. III. n. 4.



TAB. III. n. 6.

TAB. III. n. 7.

TAB. III. n. 8.

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or Pœnician *Samech* (6), nearly as it appears in the famous Maltese inscription, and not unlike the form of that element exhibited by one of those found at Citium, now in the Bodleian Library, Oxon. The fourth and sixth are so (7) like the Punic and Phœnician *Ghimel* that they cannot well pass for any other element. The fifth is manifestly *Hbeth* (8), though it seems to have somewhat suffered from the injuries of time. The seventh (9) greatly resembles the most common figure of *Thau*, and therefore we cannot be much mistaken if we take it for that letter. The powers of the Punic characters forming the inscription standing thus, we may, I conceive, read the whole AM SEGHEGT, or SEGEGTH, which is but a small variation from the word SEGESTE, or SEGESTA, the Greek and Latin name (10) of a considerable maritime city of Sicily; not far from Eryx, where money was coined, after the Greeks (11) had possessed themselves of the place. The medal therefore adorned with this minute Punic inscription may, without any impropriety, be supposed to have been emitted from the mint at Segesta, as the Punic words, AM SEGHEGT, or SEGEGTH, POPVLVS SEGESTANVS, appear upon it, when the Cartha-

(6) *Philosoph. Transact.* ubi sup. Vol. LIV. Tab. xxii. p. 394. *Memoir. de Litterat. &c.* ubi sup.

(7) *Philosoph. Transact.* ubi sup. Tab. xxiv. p. 408, 409.

(8) *Philosoph. Transact.* ubi sup. p. 404. & Tab. xxiv.

(9) *Philosoph. Transact.* Vol. LIV. Tab. xi. p. 99. & Tab. xxiv. p. 404.

(10) Christ. Cellar. *Notit. Orb. Antiq. Lib. II. c. xii. p. 397. 398.*

(11) Fil. Parut. *La Sicil. Num. in Num. di Segest.*

ginians were masters of that city, and occupied all the adjacent territory appertaining to it.

That the Carthaginians were actually possessed, for a certain period, of that part of Sicily where Eryx and Segesta had their situation, does not only appear (12) from antient history, but likewise from a long Punic inscription, found at the former of those places. This inscription has been (13) published by the Prince di Torremuzza, who extracted it from Sig. Antonio Cordici's manuscript history of Eryx, with a copy of which he was supplied by Sig. Dominico Schiavo, in the very valuable and learned work mentioned in the beginning of this paper.

That such rough and uncouth words as SEGHEGT, or SEGEGTH, with vowels scarce sufficient to form, or facilitate, the pronounciation, were not unknown to the Carthaginians, we may infer from the words SBAQTNI, ENKARA, ESCQVAR, FIEGKV, GHERQ, IGHASESC, and many others that occur in the remains of the ancient Punic tongue, which (14) at present exist in the vernacular language of the Maltese.

From what has been here advanced, it is incontestably clear, that SEGESTE, or SEGESTA, is a word of a Punic origin; which, indeed, has been observed by the famous Bochart. That learned au-

(12) Polyb. Diod. Sic. Liv. Orof. &c. *Univ. Hist.* Vol. vi. p. 829. et alib. Lond. 1742.

(13) *Sicil. et adjacent. insular veter. inscript. nov. collect.* &c. class. xx. p. 296, 297. Panormi, 1769.

(14) Canonico Gio-Pietro Francesco Agius de Soldanis, in *Dixionar. Punico-Maltes.* pass. In Roma, 1750.

thor has (15) sufficiently exploded the fabulous account of Acesta, the pretended founder of Segesta, given us by some of the ancient writers; though, for want of the assistance of the Punic coin before me, he could not hit upon the true name the city now in view, at least when the medal I am considering first appeared, went under amongst the Carthaginians.

As no chronological characters occur on the piece considered here, the time when it was struck cannot, with any precision, be ascertained. That operation must, however, have preceded the conclusion of the first Punic war; since the Carthaginians, by the treaty of peace which terminated that war, ceded the (16) whole of their possessions in the island of Sicily to the Romans. Nay, the medal I am endeavouring to throw some light upon was probably prior, perhaps many years, to the surrender of Segesta (17) to the Romans, in the beginning of the first Punic war, when the inhabitants of Segesta put the African garrison there to the sword, about 258 years before the birth of CHRIST; the Carthaginians seeming never to have been possessed of this ancient city, after that tragical event.

(15) Sam. Bochart. *Chan. lib. J. c. 27. p. 563, 564.* Francofurti ad Mœnum, 1681.

(16) Polyb. Liv. Oros. Zonar. &c. *Univ. Hist. Vol. vi.* Lond. 1742.

(17) Polyb. Diod. Sic. Liv. Oros. &c. *Univ. Hist. Vol. vi.* p. 829. Lond. 1742.

II.

The second of the two abovementioned (See TAB. III. n. 8.) inscriptions, which is the sixth of those published, in the place above referred to, by the Prince di Torremuzza, is composed of seven letters. Of these the first and second are undoubtedly *Ain* and *Mem*, as we may certainly infer from a similar inscription, on the reverses of other Punic coins, that have been (18) heretofore explained. The third must be *He*, as it so (19) much resembles a form of the Greek *Epsilon*; the ancient figures of the fifth element in the Greek, Phœnician, and Samaritan alphabets having (20) been originally the same. The sense of the inscription seems likewise absolutely to require this. The fourth letter is apparently *Mem* (21), as will be allowed by every one in the least acquainted with the ancient Siculo-Punic, and Siculo-Phœnician, characters. The fifth is *Hbeth*, or *Heth*, as we may collect from (22) other medals, similar to that on

(18) *Philosoph. Transact. Memoir. de Litterat. de l'Acad. des Inscript. & Bell. Lett. &c.* D. Bern. Aldret. D. Vincen. Juan de Lastanos. Peller. ubi sup.

(19) Sig. Haverc. *de Lit. Græc. Dissert.* p. 248, 249. Vid. *Syllag. Scriptor. qui de ling. Græc. rest. pronuntiat. &c.* Lugduni Batavorum, 1736.

(20) Vid. Hadr. Reland. D. Bern. de Montfauc. Don Luis Joseph Velazquez, *Chiffre. aliesque Scriptor. quam plurim.*

(21) *Philosoph. Transact. Memoir. de Litterat. de l'Acad. des Inscript. & Bell. Lett. &c.* Aldret. Lastanos. Peller. &c. ubi sup.

(22) *Philosoph. Transact.* Vol. LIV. Tab. xxiv. p. 408, 409. & Tab. xi. n. 1. p. 99, 404.

which

which this legend has been preserved. Part of this element, however, has been defaced by the injuries of time; which to demonstration appears (23), not only from coins already published, but likewise from others preserved in the cabinets of the great and the curious, to which easy access may be had. The sixth must be *Nun*, as we may conclude from all the abovementioned (24) coins. The draught of it, however, given us by the Prince di Torremuzza, seems somewhat to resemble one of the forms of *Mem*, and therefore it was probably not taken with the utmost accuracy; the Prince, perhaps, not being so thoroughly conversant with the various figures of the Siculo-Punic, and Siculo-Phœnician, letters, and learned men but little acquainted with those figures pretty frequently mistaking one similar letter for another. This character likewise is apparently different from the form of *Mem*, in the same inscription, and seems not a little to resemble the usual form of *Nun*; as will appear to every one, examining it with proper attention. The seventh is *Thau*, as will be admitted, I believe, by every one versed in this branch (25) of literature. The inscription, therefore, of which I am at present attempting an interpretation, is formed of the two words עַם הַמַּמָּה, AM HAMMA-HANOTH, HAMMEHNOTH, or HAMMENOTH, POPVLVS MENENIVS, or MENA-

(23) *Philosopb. Transact.* Vol. LIV. p. 99, 404, & Tab. xi. n. 1. p. 99. *Memoir. de Littérat. &c.* ubi sup. Pl. II. n. 7, 8, 9, 10, 12. p. 417. Aldret. Lastanof. Peller. &c. ubi sup.

(24) *Philos. Transf. Mem. de Littérat. &c.* A'dret. Lastanof. Peller. *ibid.*

(25) Barthel. Peller. &c.

RVM POPVLVS, as we may find rendered incontestable by other (26) similar coins.

In Hebrew the prefix ה is not seldom added to the (27) beginning of the proper names of provinces, cities, and towns. So וירגלו את-דהעי, AND VIEW-ED AI. Jehof. vii. 2. מן השטים עד הגלגל, FROM SHITTIM TO GILGAL. Mich. vi. 5. וכל-ערי הגלעד, AND ALL THE CITIES OF GILEAD. Jehof. xiii. 25. To which I could add many more instances of the same mode of expression, that might, with equal facility, be produced. As the Punic and Phœnician languages therefore (28) agreed in most points with the Hebrew, we may naturally suppose the Phœnician, or Carthaginian, inhabitants of Menæ to have impressed the words עם הממנות, AM HAMMENOTH, upon their most ancient coins.

The medal, which has conveyed down to us this inscription, through such a series of ages, is of the tetradrachmal form, and of a very considerable antiquity. It has a place assigned it in the (29) very valuable cabinet of the Prince di Torremuzza, though he has not favoured us with a draught of it. On one side it exhibits the head of a woman, goddess, or tutelary deity of the place where it was struck, with three fishes sporting round it; and on

(26) *Phil. Transf. Mem. de Litterat. &c.* Aldrez. Lestanos. Peller. ubi sup.

(27) Johan. Buxtorf. *Thesaur. Grammat. Ling. Sanct. Hebr.* p. 385. Basileæ, 1651.

(28) Sam. Bochart. *Chan.* lib. II. c. 1. *Philosoph. Transact.* Vol. LIII. p. 292. & Vol. LIV. p. 134.

(29) *Sicil. et adjacent. insular. veter. inscript. nov. collect. &c.* cl. xx. p. 293. Panormi, 1769.

the reverse a horse's head, under which appears the inscription, that is one of the principal objects of my attention, in this paper. It will be almost needless to remark, that the horse's head is one of the most usual symbols on the reverses of the antient Carthaginian coins.

With regard to the third character here, taken by me for *He*, I would beg leave to remark, that it is the crescent, or lunated form of the Greek *Epsilon*; which was a figure of that element of a pretty high antiquity, though not the (30) first used by the Greeks. That it was as early in Sicily as Julius Cæsar's days, has been proved from (31) the coins of Entella, coeval with that emperor. And that it was known in Italy many years, perhaps several generations, before (32) the finishing stroke was given to the Roman republic, is clearly evinced by a most curious minute Greek sepulchral inscription, published by P. D. Gianfrancesco Baldini, of which a particular account will be found in the very valuable work referred to here. Nay, in Greece it seems to have a long time preceded this monument (33), as may be inferred from two minute inscriptions preserved on two antient Greek statues of Speusippus and Xenocrates, mentioned by a very learned modern author. It may therefore, with sufficient

(30) Sig. Haverc. *De Lit. Græc. Dissert.* p. 248, 249. in *Sylloge Scriptor. qui de ling. Græc. ver. et rect. pronun. &c.* Lugdun. Batavorum, 1736.

(31) Fil. Parut. *La Sicil. num.* Tab. cxiv. n. 2, 3. Sig. Hav. ubi sup.

(32) *Sag. di Dissertaz. Accademich. di Corton*, Tom. II. p. 157. In Roma, 1738.

(33) Sig. Haverc. ubi sup. p. 248.

propriety, be supposed as ancient as at least the later ages of the Carthaginian empire in Sicily, if not much older. That the most ancient form of the Greek *Epsilon* was also sometimes impressed upon the Punic medals of Menæ, is rendered incontestable by a most valuable tetradrachm of that city, published (34) by M. Pellerin. The first letter of the legend, on the reverse of that tetradrachm, is the Punic *Ain*, not very accurately taken; and the third is undoubtedly the oldest Phœnician, Samaritan, and Greek figure of *He* or *Epsilon*, brought by Cadmus out of Phœnicia, and representing, according (35) to Euri-

(34) Peller. *Recueil de Medaill. &c.* Tom. Troisième. p. 22. pl. 88. n. 8. A Paris, 1763. The city of Menæ, the *Mnæ* of Ptolemy, was built by Deucetius, king of the Siculi, but subject to the Carthaginians, from the days of Dionysius the elder, king of Syracuse, to the time of Timoleon, the Corinthian, according to Diodorus Siculus; in some part of which interval, the piece I have been considering, as well as all others similar to it, was probably struck. From Menæ's being a town of the Siculi, and inhabited by them and the Greeks, M. Barthelemy infers, that it never was subject to the Carthaginians, and that therefore the piece in question could not possibly have made its first appearance there. But the former of these assertions is expressly contradicted by Diodorus Siculus, and therefore the latter of them must necessarily fall to the ground. Of this the learned antiquary above-mentioned seems to have been sufficiently aware, when he declares, that he does not give us for demonstration what he has advanced on this head. I must beg leave here farther to remark, that the word מנא cannot well be translated *Castrâ* here, as the proper names of cities are generally, if not always, pointed out to us, by the legends on the reverses of such coins. Diod. Sic. lib. xi. c. 78. Vid. etiam lib. xii. xiii. xiv. See the *Univ. Hist.* Vol. VII. p. 535. Lond. 1747.

(35) Euripid. et Agath. Tragic. apud Athen. *Deipnosoph.* lib. x. c. 20.

piles,

pides, and Agathon, in Athenæus, an obliquated trident. That inscription is formed of the very same letters with those that constitute the legend I am considering, and consequently will admit of the same interpretation. Nor can this be matter of surprize to those who consider, not only that the first figure of the Greek *Epsilon* was (36) borrowed from the earlier Phœnicians, but likewise that the later form of that element, which was also sufficiently ancient, as I have here incontestably proved, might likewise have been deduced from a later figure of the Phœnician, or Punic, *He*, in a country chiefly occupied by the Greeks (37), Phœnicians, and Carthaginians, for a very considerable period. And that this was really the case, from the legend on the reverse of the coin of which I am now attempting an interpretation, seems abundantly clear. The Prince di Torremazza has likewise (38) rendered the antiquity of this form of the Phœnician, or Punic, *He* incontestable. All which considerations being maturely weighed, and due attention given to the medals here described; the power of the third element of the legend, or inscription, before me, will appear, I would flatter myself, to be sufficiently ascertained.

(36) Edm. Chishul. *Inscript. Sig.* Sig. Haverc. ubi sup.

(37) Herodot. Thucyd. Polyb. Diod. Sic. Liv. Strab. Orosi Zonar. &c.

(38) *Prolegom.* p. 39, 40. From the Siculo-Punic medals mentioned in this paper, as well as many others, it seems clearly to appear, that the prefix Π was never annexed to the word $\square Y$, AM, POPVLVS, on the Siculo-Punic coins, as M. Barthelémy has been pleased to assert, but to the proper name of the place immediately following it. This, if allowed, must be decisive in favour of what I have formerly advanced, relative to the power of the character taken by that learned antiquary for *He*, but by me for *Mem. Philosoph. Transact.* Vol. LIV. p. 397.

If what has been just advanced should be admitted by the learned, they will readily allow the oldest forms of *He* on the antient Siculo-Punic coins, to have greatly resembled, or rather to have been almost perfectly the same with, those of that letter exhibited by the earliest Phœnician, Samaritan, Greek, and Etruscan, coins. Nor can any thing be more consonant to the faith of history than such a notion. We cannot therefore suppose *He* to have resembled any of the forms of *Mem*, or rather to have been represented by one of those forms, as M. Barthelemy (39), without any just grounds for his opinion, has actually supposed, as nothing seems more remote from truth than such a supposition. Antient history, antient coins, and the reason of the thing itself, notwithstanding his exalted merit, and the great figure he so justly makes in the republic of letters, decide the point in question most clearly and evidently against him.

Nor will it avail him to (40) assert, that the Greek coins of Menæ differ in several respects from those considered by me in this paper; and that the (41) workmanship of the latter is better than that of the pieces which are the acknowledged productions of that city. For that the workmanship of several of the Punic and Phœnician coins is highly finished and elegant, and that the taste and genius of those coins differ considerably from the manner of those struck by the Greeks and the Romans, will not admit of a doubt.

(39) Barthel. in *Memoir. de Litterat. &c. de l'Academ. des Inscrip. & Bell. Lettr. &c.* Tom. XXX. p. 409, 410, 411, 417.

(40) Barthel. *Lettre a Mons. le Marquis Olivieri, &c.* p. 28, 29. A Paris, 1766.

(41) Id. *ibid.* p. 28.

The former have not their reverses diversified by such a variety of symbols as have the latter. The Carthaginians, in particular, seem to have adorned their medals with very few symbols, or types; and those such as were, for the most part, common to all the cities and towns subject to their republic. As the legend therefore, on the reverse of the medal I have been endeavouring to explain, is clear and express in favour of my explication, and plainly points out to us the place where it was struck; the above-mentioned (42) objections, hinted at by M. l'Abbé, after what has been just observed, will fall to the ground of course, and not be allowed, by the best and most competent judges of the point in question, to have the least tendency to invalidate what has been advanced in favour of my opinion.

Several curious particulars, not hitherto touched upon, are deducible from the coin, or rather my explication of the coin, I have been considering. But as I have already exceeded the limits proposed to myself, when I began this paper, it is time to conclude; which I shall beg leave to do, with assuring you, that I am,

Good Sir,

Your much obliged,

and most obedient, humble servant,

Christ Church, Oxon.

October 2, 1770.

John Swinton.

(42) *Lettre à Mons. le Marquis Olivieri, &c.* p. 27, 28, 29.

XIII. *Extract of two Letters from M. Messier, of the Royal Academy of Sciences, and F. R. S. to M. de Magalhaens, on a new Comet : Translated by Dr. Bevis, F. R. S.*

Read Jan. 24, and Feb. 1, 1771. **P**LEASE, Sir, to inform the Royal Society, that I discovered a new Comet, the 10th of Jan. instant, 1771, about eight o'clock in the evening; it was between the head of Hydra and the Little Dog, over the parallel of Procyon. The position whereof I determined by comparing it with that star, and the star δ in Hydra. The observations are as follow :

1st Obs.	{	The 10th of Jan. 1771, at	10 16 45	true time.
		Right Ascens. of the Comet	121° 47 15	
2d Obs.	{	North Declination	5 21 15	
		Same night at	21 19 5	
3d Obs.	{	Right Ascens. of the Comet	120 24 31	
		North Declination	6 4 46	

From which observations it appears, that in $3^h 2' 20''$ of time its motion in right ascens. was $1^{\circ} 22' 45''$ and $43' 31''$ in declination : this comet was perceived by the bare eye. In the telescope its nucleus is bright, of a whitish complexion, and not very well defined, surrounded with an atmosphere several minutes wide, with a faint tail 5 or 6 degrees long. Its apparent motion among the fixt stars contrary

trary to the order of signs, from the equator towards the North pole.

This makes the twelfth Comet I have discovered and observed in thirteen years past.

WITHOUT what I had done the 10th of January for determining the position, and forming any tolerable conjecture of the direction of the motion of the comet, it would have been impossible for me to have found it afterwards; for from the 10th to the 16th the sky was every night quite clouded, during which the light of the comet had extremely abated, and its motion decreased, insomuch that between the 16th and 17th of January the sky clearing, I sought for it two hours, without finding it; but though with little hopes of seeing it, I sought for it in Perseus and Andromeda. After a world of useless pains and look-outs, at length I saw it again, between the horns of the Bull, of a very feeble light: and it was necessary to be acquainted with the heavens as well as I was, to find where it was; nor have any of our astronomers, as far as I can yet learn, succeeded in their attempts. I observed it January 10th, 16th, 17th and 20th, on which last day it was extremely close to the planet Mars, less than a minute of time, both in right ascension and declination, and its light so languid as to be in a manner extinguished by that of Mars. Without that excellent telescope which you procured for M. le President de Saron, I should not have perceived it with any of my instruments. Here follow my observations, which may possibly turn out the only good ones, and which I intreat you to lay before the Royal Society.

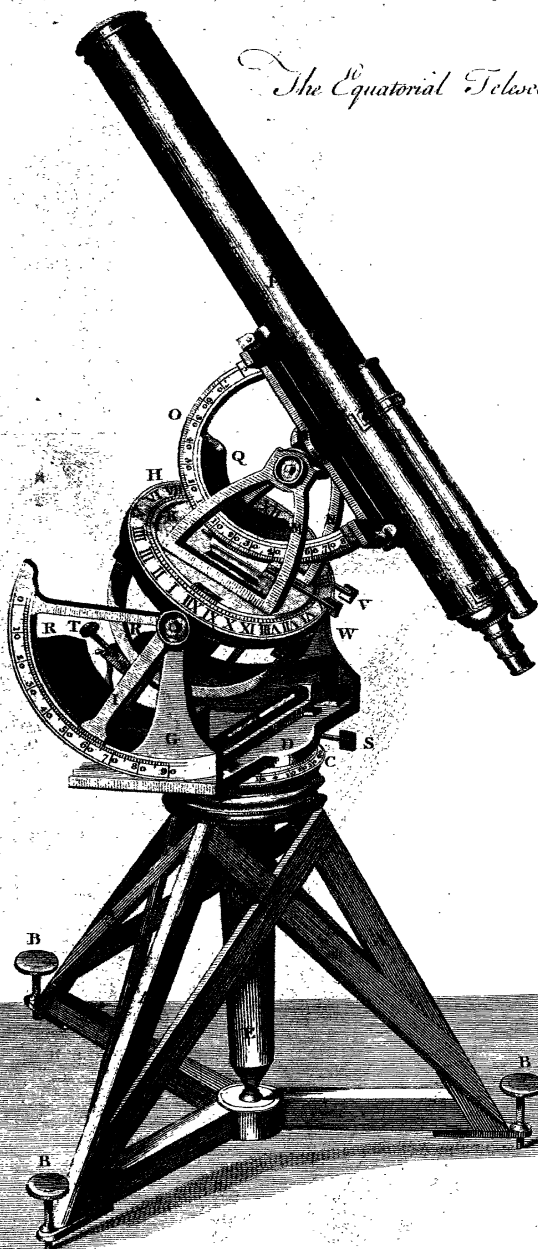
1771	True Time.	R. Ascension	No. Declin.	
	h ' "	° ' "	° ' "	
Jna. 10	8 44 24	122 27 46	5 4 37	Estimate position to δ Hydræ.
	10 16 45	121 47 16	5 21 15	{ Determined position by a * of the 7th mag. then unknown, as also by δ Hydræ.
	10 46 31	121 35 31	5 36 51	By δ Hydræ.
	12 48 58	120 49 16	6 1 47	By the same * of Hydræ, repeated.
	13 19 5	120 24 31	6 14 46	By Procyon.
16	7 16 4	84 3 17	22 39 21	By ξ the South horn of the Bull.
	7 41 39	84 1 32	22 40 51	By the same.
17	6 27 35	80 41 58	23 45 25	{ By Flamsteed's 121 of Taurus and the 163 of La Caille.
	6 40 34	80 40 28		
	7 2 37	80 37 13	23 46 51	By the same.
	7 21 23	80 35 28		By the same *.
20	8 18 30	72 52 2	25 55 25	By a * of the 8th mag. observed on the merid.
	8 18 30	72 52 25	25 55 28	By the planet Mars.
	8 56 49	72 47 47	25 56 47	By the above * of the 8th mag.
	8 56 49	72 48 17	25 56 46	By the planet Mars.
	9 19 24	72 47 17	25 57 3	By the above * of the 8th mag.
	9 19 24	72 47 32	25 57 4	By Mars.

Such are my observations, from whence M. Pingré has deduced the following Elements of its orbit.

Ascending α	3. 18 42 10
Indication of the orbit	31 25 55
Place of the perihelion	8. 28 22 44
Log. of the perihel. dist.	9.722833

Passed the perihel. the 22d of November, 1770, at 22^h 5' 48" M.T. at the royal observatory, motion retrograde. He adds, "that this comet resembles none of those whose elements are determined, on comparing its motion with the places of its Perihel and α : it is easy to see, that it was impossible to discover it at Paris before the year 1771; and it may even be added, that it must frequently have passed in the Sun's neighbourhood, imperceptible to the Northern parts of the Earth."

The Equatorial Telescope.



XIV. Description and Use of a new constructed Equatorial Telescope or portable Observatory, made by Mr. Edward Nairne, London.

Read Feb. 7. 1771. **T**HE Instrument consists of the following parts (see the annexed Plate, TAB. IV.) a mahogany triangular Stand A A A, and three adjusting screws B B B; a moveable azimuth Circle C, which is divided into degrees, and by a vernier index to every 6 minutes; above this azimuth Circle is the horizontal plate D, to the under part of which is fastened the vertical conical axis E; on the middle of the upper surface of the horizontal plate, is placed a ground glass Level F, by which the plate D is set parallel, and the pillar E perpendicular to the horizon; from this plate rise perpendicularly two quadrants G G, one of which is divided for the latitude into half degrees, and has a vernier index to 3 minutes; the equatorial plate H, with its hour circle, is supported by the two quadrants G G; its axis of motion (which is placed near the hours XII. XII.) passes through the centers of the quadrants, and carries the index I, pointing to the divided quadrant; the equatorial plate is divided into half degrees, and has a vernier index shewing every 3 minutes of right ascension or 12 seconds of time; it is figured to shew

both degrees and time; to prevent misapprehension, it may be right to remark that the hours XII. XII. ought properly to have been placed according to the meridian line; they are here placed otherwise, for the convenience of better seeing the meridian distance shewn by the vernier; On the upper part of the equatorial plate is the plate K; upon this plate K, are fixed the two supporters MM, which support the axis N, under which is fastened the semicircle of declination O, divided into half degrees, and has a vernier index subdividing it to 3 minutes; on the upper part of this axis, is fixed an achromatic Telescope P, which magnifies about 50 times; to the eye End of this Telescope, is applied a small reflecting speculum making an angle of 45° with the axis of the telescope, whereby objects that are in the zenith or any other altitude may be observed, without putting the body in any inconvenient position; to the under part of the axis N, is fastened a brass arm carrying the weight Q, which counterbalances the telescope, and the brass work annexed to it; whilst the weights R R counterbalance in like manner the whole of the instrument that is moveable on the equatorial axis, so that whatever position the instrument is put in, it will there remain, being perfectly balanced; the four motions of this instrument may, when required, be moved extremely slow, by means of the indented edges of the circle and semicircles, and the screws or worms to which the handles are fixed, *viz.* that for the horizontal motion marked S, called the horizontal handle, that marked T the handle of latitude, V the equatorial handle, and W the declination handle.

To

To adjust the instrument for observation, the first thing to be done is to make the horizontal plate D level, by means of the spirit level, and the three adjusting screws at the bottom of the stand ; this being done, move the equatorial plate either with or without the latitude handle, until the index on the quadrant points to the latitude of the place ; and then the equatorial plate will be raised, to the elevation of the equator of the place, which is equal to the complement of the latitude (and which, if not known, may likewise be found by this instrument, as will appear hereafter) ; and thus the instrument is ready for observation. The manner of using this instrument for the following observations, I shall borrow in part from the words of the late ingenious Mr. Short, in his description of his equatorial telescope*, which, however, differs essentially in construction from this.

To find the Hour of the Day, and the Meridian of the Place.

First, find from astronomical Tables, the Sun's declination for the day ; and for that particular time of the day ; then set the declination femicircle to the declination of the Sun, taking particular notice whether it is North, or South ; and set the declination femicircle accordingly, you then turn about both the horizontal handle and equatorial handle, until you find the Sun precisely concentric with the field of the telescope ; if you have a clock or watch at hand, mark that instant of time, and by looking upon the equatorial plate and vernier index, you will find

* Vide Phil. Trans. Vol. XL. p. 242.

[110]

the exact apparent time of the day, which, comparing with the time shewn by the clock or watch, shews how much either of them differ from apparent time; in this manner you find the hour of the day.

To find the Meridian of the Place.

[The instrument remaining as in the last observation.]

You first move the plate K. until the vernier on it cuts the 12 o'clock hour, and, discharging the screw to which the declination handle is fixed, turn the telescope down to the horizon, and observe the point which is then in the middle of the field of the telescope, or cut by the intersection of the cross wires, and a supposed line drawn from the center of this field, to that point in the horizon, is your meridian line, where a mark may be set up in order to preserve it; you may likewise preserve this line, by the azimuth circle, which being made moveable, should be turned so as to bring the 0 of the azimuth plate to agree with its vernier, when the telescope is pointed to the meridian; this motion in the azimuth plate will be found very convenient, since you may thus recover the meridian line by it, and it will shew the exact azimuth of any object the telescope is directed to, without disturbing any other part of the instrument: the best time of the day for making this observation for finding your meridian, is about three hours before noon, or as much after noon; the meridian of the place may be found by this method very nearly, and, if proper allowance be made for refraction,

fraction, it may be found to great exactness ; this line once settled, will save trouble afterwards, and is indeed the foundation of all astronomical observations.

To find a known Star or Planet at any proposed instant of time, whether in the day or night.

The instrument remaining rectified as in the last observation ; set the declination semicircle to the declination of the planet, at the proposed instant, and bring the index of the equatorial plate, to point to the meridian distance of the star or planet, at the proposed instant if westward, or to the complement of the meridian distance if eastward of the meridian. (This distance is found by adding together the right ascension of the Sun in time, and the apparent time of the day, and taking the difference between the sum and the star's right ascension in time ; when the star's right ascension in time is greater than the above sum, the meridian distance will be East ; when the star's right ascension is less than the sum, the meridian distance is West.) Having thus set the Instrument, look through the telescope, you will see the star or planet ; and if it should afterwards get out of the field, you will easily recover it, by moving the equatorial handle only, provided the star is above the horizon, because the diurnal motion of a star is parallel to the equator.

By this instrument most of the stars of the first and second magnitude may be seen even at midday, and the Sun shining bright, as also Mercury, Venus, and Jupiter ; Saturn and Mars are not so easy to be seen, in the day time, upon account of the faintness of their

heir light, except when the Sun is but a few degrees above the horizon ; in the same manner in the night time, when you can see a star or planet, or any new phænomenon, such as a comet, you may find its declination and meridian distance or complement thereof, by turning about the equatorial handle and declination handle, untill you see the star, planet, or new phænomenon ; and looking upon the equatorial plate, you find its meridian distance or complement thereto, and upon the declination semicircle its declination. In order to have the other uses of this instrument, you must set it to the hour XII on the equatorial plate, and to 0 on the semicircle of declination, and set the axis E perpendicular to the horizon, and then this instrument becomes an Equal Altitude Instrument, a Transit Instrument, a Theodolite, a Quadrant, an Azimuth Instrument, and a Level ; the manner of applying it to these different purposes is obvious.

The following is one Example of its Uses in finding the Altitude of any Object.

Set 0 of the semicircle of declination, to agree with 0 of its vernier index, and fasten it there ; fix likewise the vernier of the equatorial plate to 12 o'clock, or 0 degrees ; then, having set the axis E perpendicular, by means of the level F, turn the instrument about horizontally upon the axis E, and vertically upon the axis of motion of the equatorial plate, until the object appears in the middle of the field ; and the index I will point out upon the quadrant
G,

G, the zenith distance of the object, the complement of which to 90° is its altitude; hence the greatest or meridian altitude may be found, from which the latitude of the place may be deduced in the usual manner.

XV. *Experiments to shew the Nature of Aurum Mosaicum: By Mr. Peter Woulfe, F. R. S.*

Read, Feb. 14.
1771.

THE Aurum mosaicum is known by the names of Aurum musivum, Aurum mulicum, and Purpurina. We can collect but very imperfect ideas of this preparation, from the writings of antient and modern chemists. It is true, that the method of making it has been described by many; but no one hitherto has led us into the knowledge of its nature, by a sufficient number of experiments. It has been much used formerly as a pigment, but is now almost laid aside, and the Bronzes substituted in its place. It is sometimes used in medicine as a vermifuge, but how improper and uncertain it is for that purpose, will appear by the following experiments.

The best preparation described hitherto for making Aurum mosaicum, is set down in the London Dispensatory, and is as follows.

Take of tin twelve ounces, of flowers of sulphur seven ounces, of sal ammoniac six ounces, and of purified mercury six ounces; melt the tin, and add the mercury to it; and when cold, powder it, and mix with it the sal ammoniac and sulphur. Sublime the mixture in a matraass. The Aurum mosaicum will

will be found under the sublimate, with some drops at the bottom *.

Ætiology of the Operation.

As soon as the mixture grows warm, the tin acts on the sal ammoniac, and sets free its volatile alkali; and this, having a great affinity with sulphur, joins with a great part of it †, rises in the sublimation, and is totally dissipated. The portion of tin, which acted on the Sal ammoniac and set free its volatile alkali, unites with the acid of salt of the sal ammoniac, and forms a salt of tin, which sublimes ‡. The mercury, which was added only in order to divide the tin, unites with some of the sulphur, and likewise sublimes and forms a cinnabar. The tin which remains, unites with the remaining sulphur, and forms the Aurum mosaicum, which is found in the bottom of the matrafs. Instead of performing this operation in a matrafs, I have used a glass retort, fixed in a black lead crucible, with sand round it; the crucible was put into a proper furnace, and a charcoal

* The proportion formerly used was equal parts of each, which in the quantity of tin here employed, viz. $\frac{3}{4}$ 12, produced only $\frac{3}{4}$ 13½ of Aurum mosaicum; whereas the same quantity of tin in the proportion of the London dispensatory afforded $\frac{3}{4}$ 16.

Troy weight was made use of in all the following experiments.

† Sulphur combined with volatile alkali forms a volatile liver of sulphur, called by Mr. Boyle volatile tincture of sulphur and quick lime.

‡ Filings of tin, calx of tin, or tin divided by amalgamation with mercury, distilled with sal ammoniac, &c. decomposes it, whereby its acid of salt unites with the tin, and its volatile alkali is set free.

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fire made round it, an adopter was luted to the retort, and to the adopter a quilled receiver; a long vial was fitted to the quill of the receiver, in order to hold the liquor that distilled.

It will be easy by this apparatus to perform the operation without any considerable loss, provided the fire be well regulated. It is necessary to make a very slow fire at first, in order to condense the volatile fumes; for a great quantity of air is set free, when the ingredients begin to act on one another. The fire should be rather slow for the first four or five hours, and then gradually increased, until the crucible becomes moderately red hot; in which state it is to be continued during the rest of the operation, which commonly lasts about sixteen hours from the beginning to the end.

If this operation be performed for the sake of the Aurum mosaicum only, or for its sublimate, it may as well be done in a matraass or body; and in that case there is no great loss of the sublimate.

Twelve ounces of tin with sulphur, sal ammoniac and mercury in the proportion of the London dispensatory, prepared in this manner produced,

	3 3 3
* Of volatile liver of sulphur, liquid and dry	1 4 2
Of sublimate found in the retort and } adopter	13 2 0
Of Aurum mosaicum	16 0 0
Loss in the operation	0 1 1
Weight of all the ingredients	<hr/> 3 31 0 0

* The volatile liver, for the most part, comes over liquid, and is often found in the long vial in form of most beautiful ramifications, which are a crystallization of the volatile liver.

The

This operation was often repeated, and always with some little variation in the products, owing to the management of the fire, which cannot be always made alike.

If this preparation be made with too great a degree of fire, the Aurum mosaicum will be partly melted, or of a dark colour; and if the fire be not continued for a sufficient time, a portion of the cinnabar and salt of tin will remain with the Aurum mosaicum.

The Sublimate of Aurum mosaicum examined.

The sublimate, which was obtained in preparing the Aurum mosaicum weighing $\frac{3}{4}$ 13 $\frac{3}{4}$ 2 was finely powdered and digested with distilled water sharpened with some acid of salt*, and when cold was filtered; more water was added to what remained in the filter, by which means it was deprived of its soluble part.

† The undissolved part of the sublimate dried, and then sublimed in a retort, produced $\frac{3}{4}$ 9 $\frac{1}{2}$ of cinnabar, which was of a dark colour, owing to an excess of sulphur; there came over into the receiver a small quantity of an acid liquor, and there was found in the retort $\frac{3}{4}$ $\frac{1}{2}$ of Aurum mosaicum, which added to the former quantity makes $\frac{3}{4}$ 16 $\frac{1}{2}$.

The soluble part of the sublimate is composed of tin united to the acid of salt; in order to know the quantity of tin which it contains, a sufficient quantity of fixed alcali dissolved in water was added

* Salt of tin mixed with water becomes turbid, and a portion of the tin precipitates; therefore the acid of salt was added, to prevent the precipitation.

† This contains some running mercury; but in the sublimation it disappears, and forms cinnabar.

to it, by which means the tin was precipitated; this precipitate weighed $\frac{3}{2} \frac{3}{7}$.

An ounce of tin dissolved in the acid of salt *, being precipitated with a solution of fixed alkali in water, well washed and dried † weighed $\frac{3}{2} \frac{1}{4}$; so that a precipitate of tin contains only $\frac{4}{7}$ of tin, and therefore the $\frac{3}{2} \frac{3}{7}$ of precipitate obtained from the sublimate contain only $\frac{3}{2} \frac{3}{2} \frac{1}{2}$ nearly of tin; this being deducted from $\frac{3}{2} \frac{1}{2}$, the quantity of tin used in the operation, makes $\frac{3}{2} \frac{9}{3} \frac{5}{2}$, which is the real quantity of tin contained in the $\frac{3}{2} \frac{1}{6} \frac{1}{2}$ of Aurum mosaicum obtained in this process; therefore $\frac{3}{2} \frac{1}{1} \frac{7}{8}$ of Aurum mosaicum contains $\frac{3}{2} \frac{1}{1}$ of tin, and $\frac{3}{2} \frac{1}{1} \frac{7}{8}$ of sulphur; for $\frac{3}{2} \frac{9}{3} \frac{5}{2}$ of tin is to $\frac{3}{2} \frac{1}{6} \frac{1}{2}$ of Aurum mosaicum, as $\frac{3}{2} \frac{1}{1}$ of tin is to $\frac{3}{2} \frac{1}{1} \frac{7}{8}$ nearly of Aurum mosaicum. This will be further illustrated by other experiments.

The tin, which was precipitated by adding a fixed alkali to the soluble part of the sublimate, was distilled with iron filings and fixed alkali; but no mercury was obtained. This shews that none of the mercury unites with the acid of the sal ammoniac.

There was no volatile alkaline smell produced by the addition of fixed alkali to the soluble part of the sublimate, though there were an excess of it added; which proves that the sal ammoniac was totally decomposed.

* The vapour, which arises in dissolving tin in the acid of salt, becomes inflammable, when the solution is made in large quantity, by means of heat; the like happens also with regard to lead.

† This precipitate, if dried with too much heat, takes fire, and burns like a dried plant that contains nitre.

The

The soluble part of the sublimate of Aurum mosaicum produces crystals of an irregular form, which do not deliquesce in the air like all other salts of tin, owing chiefly to their having a less portion of acid. A drop of the solution of this sublimate, crystallised on a piece of glass, and viewed with a microscope, has very much the appearance of the crystals of alum.

Aurum mosaicum, when well prepared, is of a shining golden colour, has no taste, and is not soluble in water. It is not acted on by acids, nor by fixed or volatile alkalis dissolved in water. If melted with an equal quantity of fixed alkaline salt of tartar, it forms a liver of the colour of gumbouge, which is, for the most part, soluble in water, and may be precipitated by any acid.

If Aurum mosaicum be distilled with iron filings, no mercury will be obtained.

It is well known, that tin deflagrates violently with nitre; therefore it will not seem surprising, that the Aurum mosaicum should have that property in a far greater degree, it being a composition of tin and sulphur*.

Sulphur, combined with metallick substances, renders them inactive, as we see in cinnabar, antimony, &c.; therefore Aurum mosaicum well prepared must be a very unfit medicine for worms.

Aurum mosaicum is often found to have a very rough taste; but that is owing to the salt of tin, which has not been sufficiently dissipated in the sublimation, and, in that state it may effectually destroy

* May not this substance be useful in fire-works, as also sulphurated iron?

worms; but it must be allowed to be a very uncertain medicine, and perhaps dangerous, as it may contain too small or too great a quantity of the salt of tin.

If salt of tin be good for worms, it would be right to ascertain its dose, and give it in a proper vehicle.

Tin combined with Sulphur, by Fusion.

Four ounces of tin melted and saturated with sulphur weighed $\frac{3}{5}$, and formed a black shining flaky brittle substance when melted. The tin need not be made quite red hot for this operation; for, when the sulphur is mixed with it, a deflagration ensues, and the mixture grows red hot. In order to saturate the tin with as much sulphur as possible, it must be added to it at two or three different times. The tin, notwithstanding, cannot be, by this means, perfectly saturated with sulphur; for after powdering and sifting it, there remains in the sieve a portion of the tin, which will flat under the pestle, and not powder any more, unless melted and combined with more sulphur. If this operation be done with too great a degree of fire, the increase of weight will not be so considerable, on account of the great fire, which dissipates some of the sulphur.

Four ounces of Aurum mosaicum melted in a covered crucible loses $\frac{3}{6}$ of its weight, and becomes a mass somewhat like melted sulphurated tin, though it be not so shining, nor so flaky, but rather more of a needle form. If the fusion be repeated two or three times, some of its sulphur will be each time dissipated, and have exactly the appearance of sulphurated tin.

Aurum

Aurum mosaicum melts much more readily than sulphurated tin; and that, because it contains a greater quantity of sulphur.

Sulphurated tin, by calcination, is totally deprived of its sulphur and phlogiston. $\frac{3}{4}$ of tin saturated with sulphur, and then carefully calcined weighed $\frac{3}{4} 4\frac{1}{2}$, so that a calx of tin prepared in this manner, weighs $\frac{1}{9}$ more than the tin it contains*.

Four ounces of Aurum mosaicum calcined in the same manner, weighed $\frac{3}{4} 3, \frac{3}{4} 2, \text{D } 1$, which, being a calx of tin, of the nature of that made with sulphurated tin, contains $\frac{1}{9}$ less of tin, which $\frac{1}{9}$ being deducted, makes $\frac{3}{4} 2, \frac{3}{4} 7, \text{D } 1$, gr. $4\frac{1}{2}$, the quantity of tin contained in $\frac{3}{4} 4$ of Aurum mosaicum†. An ounce of Aurum mosaicum carefully calcined, and reduced with flux, produced only $\frac{3}{4} \frac{1}{2}$ and gr. 11 of tin: we may conclude from the foregoing experiments, that $\frac{3}{4} 1$ of Aurum mosaicum contains more than this quantity of tin; but it is well known that metallick bodies, which have been much calcined, and especially tin and zinc, always lose in their reduction.

Aurum mosaicum will be of a black colour, if too small a quantity of sulphur be used, and if the fire be too strong and too long continued †.

* All metallick substances, and even zinc, though a good deal of it dissipates in flowers, increase in weight by calcination.

† It is almost impossible to calcine Aurum mosaicum, without some loss; for it is so light and subtil, that it cannot be stirred without dissipating some of it; therefore the quantity of tin which it contains, cannot be exactly ascertained by this means.

Receipts for making Aurum Mosaicum without Mercury.

1st. Take $\frac{3}{8}$ of granulated tin sifted through a fine sieve, and mix it well with $\frac{3}{6}$ of sulphur, and $\frac{3}{4}$ of sal ammoniac; put the mixture into a matraße or body, and calcine it for six or seven hours. The Aurum mosaicum hereby obtained is not of so bright a colour, as that made in the usual manner; and that, on account of the tin not being sufficiently divided in order to unite well with the sulphur.

2d. Take $\frac{3}{8}$ of tin reduced to a calx by calcination, and mix it well with $\frac{3}{7}$ of sulphur, and $\frac{3}{4}$ of sal ammoniac; calcine it as the former. This makes a good coloured Aurum mosaicum, though it be found here and there of an unequal colour, owing to some of the tin, which had been too much calcined, and thereby prevented from uniting with the sulphur.

3d. Take $\frac{3}{8}$ of tin, and saturate it by fusion with sulphur, powder and mix it well with $\frac{3}{5}$ of sulphur, and $\frac{3}{4}$ of sal ammoniac; calcine the mixture as before. This produces a good coloured Aurum mosaicum.

Receipts for preparing Aurum Mosaicum, without Mercury or Sal ammoniac.

1st. Take $\frac{3}{8}$ of tin, saturate it by fusion with sulphur, and mix it with $\frac{3}{4}$ more of sulphur, and calcine as before, but with a less degree of fire. This forms rather a dark coloured Aurum mosaicum, owing to the sulphur which melts, and in great measure

measure separates and swims on the surface of the sulphurated tin.

2d. Take $\frac{3}{4}$ 10 of sulphurated tin, powder and mix it well with $\frac{3}{4}$ 4 of sulphur, and $\frac{3}{4}$ 2 of spirit of salt; calcine the mixture as the former. This forms an Aurum mosaicum of a tolerable good colour. This mixture soon grows warm of it self after being put into the body, and produces a penetrating vinous smell, no ways like that which is afforded by dissolving tin in the acid of salt.

In this operation, part of the tin unites with the acid of salt, and is at last dissipated in the operation.

3d. Take $\frac{3}{4}$ 8 of tin, and saturate it with sulphur, powder and mix it with $\frac{3}{4}$ 5 of sulphur; put it into a body, and pour on it $\frac{3}{4}$ 2 of volatile liver of sulphur obtained in making Aurum mosaicum, and calcine it as fore. This does not make so good a coloured Aurum mosaicum as the former, owing to the fusion of the sulphur, which in great measure separates from the sulphurated tin. Soon after the volatile liver was poured on the mixture of sulphurated tin and sulphur, it grew so hot that the body could scarcely be held in the hand.

4th. Take $\frac{3}{4}$ 4 of tin, saturate it with sulphur, powder and mix it well with $\frac{3}{4}$ 2 of sulphur, and $\frac{3}{4}$ 1 of tin dissolved in the acid of salt and crystallised; calcine it as usual. This produced $\frac{3}{4}$ 6 $\frac{1}{2}$ of very good and quite tasteless Aurum mosaicum, so that $\frac{3}{4}$ 4 of tin by its union with sulphur increased in weight $\frac{3}{4}$ 2 $\frac{1}{2}$.

This operation was done in a retort, to which there was luted an adopter and receiver, in order to collect

the salt of tin, which for the most part came over congealed.

5th. Take $\frac{3}{4}$ 10 of sulphurated tin, powder and mix it well with $\frac{3}{4}$ 16 of corrosive mercury sublimate; put it into a retort, to which an adapter and receiver is to be luted, calcine it for six hours, at first with a middling fire, and for the last three hours the retort must be red hot.

In this operation, a portion of the tin unites with the acid of the mercury sublimate; and forms the smoaking liquor of Libavius, which distills for the most part in a liquid form; the mercury contained in the mercury sublimate unites with a small portion of sulphur (about $\frac{1}{7}$ of its weight), and sublimes in form of cinnabar in the top of the retort; the remaining tin, having a sufficiency of sulphur, forms the Aurum mosaicum, which is found at the bottom of the retort of a most beautiful sparkling golden colour.

The reason for obtaining Aurum mosaicum by this operation is, that the greatest part of the tin unites with the acid of the mercury sublimate, and rises in distillation; the remaining tin has thereby a sufficient quantity of sulphur to form the Aurum mosaicum.

Some of the foregoing receipts did not well succeed at the first or second trial; and many other experiments, which did not answer, have here been omitted.

From the foregoing experiments, we may certainly conclude, that Aurum mosaicum is a combination of tin and sulphur; it contains better than $\frac{1}{7}$ of sulphur. It also appears that the only use of the mercury,

mercury is to divide the tin; and that the sal ammoniac serves only to prevent the fusion of the sulphur.

The following proportion will answer better than that of the London Dispensatory; for there will be a greater produce of Aurum mosaicum, though a less quantity of mercury and sal ammoniac be used.

Tin z 12, sulphur z 7, sal ammoniac z 3, and mercury z 3.

This proportion yields z 17 $\frac{1}{2}$ of Aurum mosaicum, whereas that of the London Dispensatory gives only z 16.

The soluble part of the sublimate of Aurum mosaicum answers far better for dying than any solution of tin; a small quantity of it with cochineal will dye silk, and especially cloth, of a fine scarlet colour; silk may be dyed of a fine crimson colour, by its means, with the addition of brazil wood, peach wood, or braziletto; but with logwood, silk and cloth may be made of a great variety of fine purple colours, which seem lasting.

The property, which this sublimate has of making finer colours than any solution of tin, engaged me to make many trials, with other preparations of tin; and I found, that when tin was united to the acid of salt, and distilled or sublimed, it would produce finer colours than any solution or combination of tin, unsublimed or undistilled.

I must be excused for the present, for not telling the reason of this; it may be discovered by examining well the products, which are obtained by making the liquor fumans of Libavius, in the common manner.

May not iron and copper, united to the acid of salt and sublimed, answer better for dying, than other preparations of iron and copper?

Most other metallick substances may be after this manner more intimately combined with a greater portion of sulphur than by fusion. Bismuth is the only one, which produced a golden colour, and that not so fine a one as Aurum mosaicum. Iron, copper, lead, and regulus of antimony, produce black combinations; arsenic forms a reddish mass like realgar; zinc does not in this manner, nor in any other way that I know, combine with sulphur.

An Apparatus for making Aurum Mosaicum in the cheapest manner.

A glass vessel cannot be used for this operation more than once, because it is necessary to break it, to get out the Aurum mosaicum. The following utensil may be employed a great number of times, and save the expence of glass.

Take a black lead crucible, N°. 60; bore a round hole in its bottom about three inches diameter; and saw off an inch of its upper edge; if it has a lip, get a round piece of burnt clay, of an inch thick or rather more, to fit exactly into this edge; the composition, which is used for making paving-tiles, answers very well for this purpose. In order to make use of this apparatus, fit the round piece of burnt clay to the inner edge of the crucible, by means of some loam softened with glue, and dry it slowly; then turn it upside down, and lay it in a proper furnace on two iron bars. The mixture for the Aurum mosaicum is to be put in through the
round

round hole at top, and then covered with an aludel and luted ; this serves to collect the flowers and the sublimate which rises. The fire is to be made under and all round the crucible. 11 lb. Troy of Aurum mosaicum may be made here at a time ; and when the operation is over, the bottom or round piece of burnt clay will easily come out with the Aurum mosaicum. A large crucible may be made use of, if a larger quantity be required to be made at once. The operation cannot fail of success, provided the fire be made of a sufficient strength, and of an equal degree from the bottom to the top of the crucible, which is easily done in a good furnace. The operation is finished in eight hours, unless the volatile liver is wanted.

White arsenic, digested with a solution of tin in the acid of salt, becomes soon black ; it does hereby regain its phlogiston, and is reduced to the state of regulus of arsenic, and will by this means readily combine with copper, and other metallick substances ; which it would not do, without the help of phlogistic substances. This is the most easy and ready way of reducing arsenic to its metallick form : the arsenic may be deprived of the solution of tin, which adheres to it by washing it with water. It is to be dried slowly, for otherwise it is apt to catch fire.

A Method of dying Wool and Silk, of a yellow colour, with Indigo; and also with several other blue and red colouring Substances.

THE Saxon blues have been known for some time ; and are made by dissolving indigo in oil of

vitriol, by which means the indigo becomes of a much more lively colour, and is extended to such a degree, that it will go very far in dying.

A receipt for making the best Saxon blue will, I dare say, be agreeable to many; I will, therefore, give the following, which produces a very fine colour, and never fails of success.

Mix $\frac{3}{4}$ 1 of the best powdered indigo, with $\frac{3}{4}$ 4 of oil of vitriol in a glass body or matrafs: and digest it for one hour with the heat of boiling water, shaking the mixture at different times; then add $\frac{3}{4}$ 12 of water to it, and stir the whole well, and when grown cold filter it. This produces a very rich deep colour; if a paler blue be required, it may be obtained by the addition of more water. The heat of boiling water is sufficient for this operation, and can never spoil the colour; whereas a sand heat, which is commonly used for this purpose, is often found to damage the colour, from its uncertain heat.

Indigo, which has been digested with a large quantity of spirit of wine, and then dried, will produce a finer colour than the former, if treated in the same manner, with oil of vitriol.

No one, that I know of, has heretofore made use of the acid of nitre, instead of the acid of vitriol; and it is by means of the former that the yellow colour is obtained: it was nevertheless natural to use it, on account of its known property of making yellow spots, when dropped on any coloured cloth.

The acid of salt does not dissolve indigo, and therefore is of no use in dying.

Receipt for making the yellow dye.

Take $\frac{3}{4}$ of powdered indigo, and mix it in a high glass vessel, with $\frac{3}{4}$ 2 of strong spirit of nitre, previously diluted with $\frac{3}{4}$ 8 of water; let the mixture stand for a week, and then digest it in a sand heat for an hour or more, and add $\frac{3}{4}$ 4 more of water to it; filter the solution, which will be of a fine yellow colour.

Strong spirit of nitre is liable to set fire to indigo; and it is on that account that it was diluted with water, as well as to hinder its frothing up. $\frac{3}{4}$ 2 $\frac{1}{2}$ of strong spirit of nitre will set fire to $\frac{3}{4}$ $\frac{1}{2}$ of indigo; but, if it be highly concentrated, a less quantity will suffice.

If the indigo be digested twenty four hours after the spirit of nitre is poured on it, it will froth and boil over; but, after standing a week or less, it has not that property.

One part of the solution of indigo in the acid of nitre, mixed with four or five parts of water, will dye silk or cloth of the palest yellow colour, or of any shade to the deepest, and that by letting them boil more or less in the colour. The addition of alum is useful, as it makes the colour more lasting; according as the solution boils away, more water must be added.

None of the colour in the operation separates from the water, but what adheres to the silk or cloth; of consequence this colour goes far in dying.

Cochineal, Dutch litmus, orchel, cudbear, and many other colouring substances treated in this manner, will all dye silk and wool of a yellow colour.

The indigo which remains undissolved in making Saxon blue, and collected by filtration, if digested with spirit of nitre, dyes silk and wool of all shades of brown inclining to a yellow.

Cloth and silk may be dyed green with indigo; but they must first be boiled in the yellow dye, and then in the blue.

XVI. *Account of an extraordinary Steatomatous Tumour, in the Abdomen of a Woman, by P. Hanly, M. D. Communicated by Charles Morton, M. D. Sec. R. S.*

Received November 8, 1770..

Read Feb. 21,
1771.

MR S. Reily, aged thirty six years, pale, tall, fleshy, and formerly of a healthy constitution, was brought to bed of a strong, lively daughter, on the twenty third day of May; 1770, in the parish of St. Anne, Dublin.

In the fifth month of her pregnancy, she felt an uncommon lump in her stomach (as she expressed it), about the size of a hen-egg, which did not then give her much pain or uneasiness, and she was in hopes that her delivery would carry it off: she had towards the end of her pregnancy frequent reachings, sometimes puked, and became emaciated; three days after she was brought to bed, she found the lump and reachings had encreased; she became very uneasy, and sent for me.

Upon examining her abdomen, I felt a considerable tumour contiguous to her stomach, which afterwards had greatly encreased, and was extended obliquely to her right side, as low as her navel; it lay immediately under the peritoneum and abdominal muscles, and in the progress of its encrease, I could

plainly feel one large, and other smaller protuberances of a firm substance, in some measure resembling the head and superior extremities of a fœtus. It could be easily moved from side to side, without giving her any pain; but it resisted, and made her uneasy, when I attempted to move it downwards: her abdomen appeared plump and full, as if she had not been brought to bed; but the hypochondres were more prominent and distended, than the region below her navel. I ordered for her the simple bitter infusion with absorbent powders, and delayed giving deobstruent medicines, till she had recovered her strength after lying-in. I also desired her not to suckle her infant; but, as her husband was poor, she did not comply, by which means she quickly became greatly exhausted and emaciated.

In a fortnight after her delivery, she got up daily, walked about her room, sometimes went abroad, and continued to suckle her child; but the reachings returned at intervals, the tumour increased in size, its protuberances became larger and more distinct, she was often restless, and in pain at night on lying in bed, had a hectic fever, and daily became weaker and more emaciated, with a sharp pinched-up nose, hippocratic countenance, small, quick, weak, thread-like pulse, loss of appetite, and night sweats.

In five weeks after her delivery, the tumour had greatly increased in all its dimensions; and its protuberances, which to the feel seemed to resemble the head, trunk, and extremities of an extra-uterine fœtus, became more palpable and distinct, as the abdominal muscles from their distension became thinner. I brought ten physicians, surgeons, and accoucheurs

coucheurs to visit her; and we were all so much deceived as to be of opinion, that the tumour was an extra-uterine foetus: however, we were deterred from attempting the Cæsarean operation, from a conviction that she was too weak, hectic, and reduced, to encourage any hopes of her recovery, in case it had been performed; and therefore we determined to leave the event to nature, especially as we could perceive no motion of any particular parts of the tumour, though it had greatly increased, and as it was possible that it might be some other tumour.

She continued gradually declining; the tumour and symptoms increasing, during May and June; and the twenty-third day of July following, I perceived a small fluctuation of water in her abdomen, and gave her an intimation thereof, which determined her to procure another nurse for her infant; but the ascites daily increased, and in nine or ten days after, her legs and feet became oedematous, her night-sweats still continued, though her dropsy augmented, and she languished under the acute-pains, more frequent reachings, hectic fever, loss of strength, want of appetite, and restless nights, except when she took an opiate, which often proved a great relief and refreshment to her.

Her posture in bed now was half sitting, half lying, which was the only position she could bear without great pain and shortness of breathing.

About seven days before her death, she was seized with a smart lax, which, in a few days, carried off part of the swelling in her left leg; she became somewhat lighter, and less distressed in her breathing, which made her vainly hope, that her disorder might
be

be carried off in that manner; but the tumour, weakness, and other symptoms encreased, till the second day of September instant when she expired.

After her death, on opening her abdomen, in presence of seven gentlemen of the faculty, we found about a gallon of water, and a large steatomatous tumour just under the peritoneum, near three inches in thickness, seven inches in length from her stomach to the obtuse angle of her ribs, and in some places near five inches in breadth from her sternum to the vertebrae of her back, full of prominences of different sizes. It was of a hard consistence, like tallow in its anterior part, but softer posteriorly, and divided by thin membranes into numerous cells, which were distended with hard and softer fat; it weighed seven pounds, was of an irregular figure, adhered to, and compressed, the anterior part of her stomach, and was so firmly united to the inferior surface of the liver, that it could not be separated from it without force. It pressed and concealed the colon, and extended from the stomach by her liver to the right ovary, and vertebrae of her back: the small guts were greatly squeezed, and mostly forced towards the left side; and the anterior lobe of her liver was so compressed between the diaphragm and tumour, that it appeared flattened, smaller than usual, and in a withered, decaying state.

There was nothing præternatural in the matrix, or any of the other bowels; but they were greatly compressed, and the tumour, from its membranes and contained fat, seemed to be a production and distension of that part of the omentum, which adheres to the stomach, although it reached and adhered

hered to the right ovarium, liver, aorta, and colon, as well as to the stomach.

The operator was for some time in search of the colon, before he found it, adhering to, and almost forming a part of, the posterior edge of the tumour.

Dublin,
Sept. 6, 1770.

P. Hanly, *M.D.*

Received February 4.

XVII. *A Letter from Dr. Ducarel, F.R.S. and F.S.A. to Dr. William Watfon, M.D. and F.R.S. concerning Chesnut Trees; with two other Letters to Dr. Ducarel, on the same Subject.*

SIR,

Read Mar. 8, 1771. **I**N a letter addrested to you, on the trees which are supposed to be indigenous in Great Britain, published in the *Philosophical Transactions* *, the Hon. Mr. Daines Barrington has attacked a prevailing notion among the learned; that chesnut trees are the native production of this kingdom. Mr. Barrington argues that they are not; and his reasonings on this, are now to be considered.

In my Anglo-Norman Antiquities, p. 96. I had observed that “ many of the old houses (in Normandy) when pulled down, are found to have a great deal of chesnut timber about them; as there are not any forests of chesnut trees in Normandy, the inhabitants have a tradition, that this timber was brought from England: and there are some circumstances, which, when rightly considered, will

* Vol. LIX. p. 23.

“ add strength to this tradition ; for many of the old
 “ houses in England are found to contain a great
 “ deal of this kind of timber : several of the houses
 “ in Old Palace Yard, Westminster, and in that neigh-
 “ bourhood, which were taken down in order to
 “ build Parliament and Bridge-streets, appeared to
 “ have been built with chesnut ; and the same was
 “ observed with regard to the Black Swan Inn, in
 “ Holborn, and many other old buildings lately
 “ pulled down in different parts of England.” And
 to this I had subjoined the following account in a
 note. “ Chesnut timber being at present rarely to be
 “ found growing in the woods and forests of Eng-
 “ land, many persons are induced to think that the
 “ sweet chesnut was never an indigenous tree of this
 “ island : but a little consideration will plainly evince,
 “ that it always was, and is to this day, a native of
 “ England. It is generally allowed, that all the
 “ ancient houses in the city of London were built of
 “ this timber. Certainly it did not grow far off ;
 “ and most probably it came from some forests near
 “ the town ; for Fitz Stephens, in his description of
 “ London, written in the reign of king Henry the
 “ Second, speaks of a large and very noble forest,
 “ which grew on the North side of it. Rudhall,
 “ near Ross, in Herefordshire, an ancient seat of the
 “ family of Rudhall, is built with chesnut, which
 “ probably grew on that estate ; for although no tree
 “ of the kind is now to be found growing wild in
 “ that part of the country, yet there can be no
 “ doubt, but that formerly chesnute trees were the
 “ natural growth of the neighbouring wood lands,
 “ since we find that Roger earl of Hereford, founder
 Vol. LXI. T of

“ of the abbey of Flaxley, in Gloucestershire,
 “ by his charter, printed in Dugdale’s monasticon,
 “ tom. i. p. 884. gave the monks there, the tythe
 “ of the chesnuts in the forest of Deane, which is
 “ not above seven or eight miles from Rudhall.
 “ The words, are *Singulis annis totam decimam casta-*
 “ *nearum de Dena.* In the court before the house
 “ at Hagley Hall, in Worcestershire, the seat of
 “ Lord Lyttelton, are two vast sweet chesnut trees,
 “ which seem to be at least two, if not three hun-
 “ dred years old; and Mr. Evelyn, in his Sylva, p.
 “ 232. mentions one, of an enormous size, at Tortf-
 “ worth, in Gloucestershire, which hath continued
 “ a signal boundary to that manor, from King Ste-
 “ phen’s time, as it stands upon record; and which
 “ tree is still living, and surrounded by many young
 “ ones, that have come up from the nuts dropped
 “ by the parent tree. Mr. Evelyn also assures us,
 “ that he had a barn framed intirely of chesnut tim-
 “ ber, which had been cut down in its neighbour-
 “ hood. In the forest of Kent, adjoining to Suffex,
 “ there still remains several large old chesnut stubbs,
 “ which were left by the woodmen as termini, or
 “ boundaries, either of parishes, or private property.
 “ Besides this, there are to this day, in the North
 “ East part of Kent, several large woods, consisting
 “ principally of chesnut trees and stubs. In the
 “ parish of Milton, near Sittingborne, is a manor
 “ called Norwood Casteney, otherwise Chesteney,
 “ from its situation among chesnut woods, which
 “ reach to the highway from London to Dover, and
 “ give name to a hill between Newington and Sit-
 “ tingborne, it being called Chesnut Hill, the ches-
 “ nut

“ nut trees growing plentifully on each side of it,
 “ and in woods round it for many miles. And
 “ by the particulars for leases of crown lands in
 “ Kent, temp. Eliz. Roll III. N^o 8. now in the
 “ Augmentation office, it appears that there is,
 “ in the same parish of Milton, a wood containing
 “ two hundred and seventy eight acres and a half,
 “ called Cheston, otherwise Chesnut wood. To
 “ conclude, my worthy friend, Edward Hasted, esq;
 “ of Sutton at Hone, near Dartford in Kent, F.R.S.
 “ and F.S.A. assures me that one of his tenants at
 “ Newington, a few years since grubbed up forty
 “ acres of wood, which were intirely chesnut.”

In the very out-set of the argument, Mr. Barrington imposes upon himself, by changing the terms of the question. “ Since you sent me, says he to Dr. Watson, the specimen of supposed chesnut, which was taken from the old hall of Clifford’s Inn, I have been at some pains to examine the authority for the prevailing notion, with regard to this being an indigenous tree” (p. 23.)—but in p. 24. he says, “ I shall begin by considering the proofs, which are commonly relied upon to the *Spanish* or *sweet* chesnut being indigenous in Great Britain.”—though not one word has preceded, though not one word follows, of the *Spanish* and the common chesnut being the same. He then alledges, “ that the very name of *Spanish*, seems strongly to indicate the country from which it was originally introduced here” (p. 24.) This is surely a striking instance of an inaccuracy of language; the whole controversy between us turns only upon that which is commonly called the chesnut tree, and which is therefore de-

nominated *Castanea Vulgaris*, by all the ancient Botanists. It is so called by Dr. Johnson in his *Mercurius Botanicus*: by the same author, in his *Iter Cantianum*; and by Blackstone, in his *Specimen Botanicum*; and in this true view of the controversy, let us examine the principal parts of it.

I have, Sir, in the abovementioned quotation, particularly noticed a large tract of chesnut woods, to continue to this day near Sittingborne, in Kent; in opposition to this, Mr. Barrington says, that he has taken a very minute inspection of these woods; and that, "finding them planted in rows, and without any scattering trees to introduce them, he is convinced that they are not natives." (p. 27 and 28) Such is the argument by which my assertion is endeavoured to be set aside.

I shall not here enter into an examination of the four general rules laid down by Mr. Barrington, "from which it may be decided, whether a tree is indigenous or not in any country," p. 23. That I leave to the consideration of two of my particular friends, who have entered into the Botanical reasons produced by Mr. Barrington, and whose letters to me on this subject are hereunto annexed. I confine myself to the fact. "Remember, says Dr. Plot "in his MS. *Collectanea of Kent* (in the library of "Edward Jacob, Esq; of Feversham) the iron oar "smelted in Chesnut wood, in the confines of Borden "and Newington." Dr. Johnson, in his *Iter Cantianum*, 1632, speaks of the *Castanea Vulgaris inter Sittingbourne et Rochester*. And this Chesnut wood is equally mentioned as early as the 22d of Elizabeth, under the title of *Quædam Sylva, vocata Chesternwode*,
in

in a conveyance, which the reader may see below (1). This wood then is not very modern; and if ever it was planted by any human hand, must have been planted two or three ages ago; but it was certainly never planted by any human hand; the whole wood

(1) Ex. Orig. penes Edw. Jacob Arm. de Feversham, S.A.S. Nov. 22, 1770. Sciant p'sent. et futur. q^d ego Georgius Clyfforde, p'ochie de Bobbynge in com. Kanc. ar. p' quadam pecunie summa michi p'fato Georgio p' Georgium Ffylmer p' manibus solut. unde fateor me fore solut. et content. dictumq; Georgium Ffylmer hered. et exec. et admynistr. suos fore exonerat. et acquietat. p' p'sent. dedi concessi vendidi et hac p'sent. carta mea confirmavi eidem Georgio Ffylmer quinque acr. ter. et bosc. sive majus sive minus scituat. jacen. et existen. in pochia de Borden in com. p'dicto videl't ad quandam filvam ib'm, voc. Chesten woode versus West ad ter. * Garret, gen'; versus Southe ad ter. hered. Alexandr. Cottye; versus Est ad boscu hered. Henrici Droumfylde; versus Northe; Est et West ad boscu Thome Pettenden, versus North; H'end. et Tenend. predict. quinque acr. ter. et bosc. cum omnibus et singulis suis p'tin. p'fat. Georgio Ffylmer hered. et assign. suis ad opus et usum ipsius Georgii Ffylmer hered. et assign. suor. imp'petu Caplitib. d'no feodi p' servis inde eis prius debet. et de jur. consuet. Et ego p'dict. Georgius Clyfford et hered. mei p'dict. quinque acr. ter. et bosci cum omnibus et singulis suis p'tin. p'fat. Georgio Ffylmer hered. et assign. suis contra omnes gentes warrantizabimus et imp'petu defendemus p' p'sentes. In cujus rei testimonium ego p'dictus Georgius Clyfford huic p'sent. cart. mee sigillum meum apposui; dat. vicesimo octavo die Maii anno regni dñe Ære Elizabeth dei gra' Angl. Frauncie, et Hib. Regine fidei defensoris, &c. vicesimo secundo.

Georgius Clyfforde, (L. S.)

Sealed and delivered
in the presence of

German Wake, &
Henry Whithead.

* Sic Orig.

covers

covers more than three hundred acres of land. In one part of Chesnut wood, upon the hanging banks of Chesnut-street, and in the way from Kay-street to Stockbury, are now the remains of large chesnut trees and pollards, which were plainly planted by the bold irregular hand of nature.

I had also mentioned a grant (or rather a confirmation of a grant) made to the abbey of Flexeley, which was the tithe of chesnuts in the forest of Dean; "*totam Decimam Castanearum de Denâ.*" But Mr. Barrington objects to the supposition "of "Dena, in the record, meaning the forest of Dean, "as there are so many places of the name of Dean "in the kingdom." This however is surely an objection of no weight. The Cistercian abbey of Flexeley, or Dene, was actually situated in the forest of Dean (2), and was anciently called Flaxlyn abbey of St. Mary de Dean (3). This abbey, together with Dean Magna (alias Mitchell Dean), and Dean Parva, all lie in the same hundred with the forest (the hundred of Saint Briannell), and are included in the ecclesiastical deanery, called Forest: where, therefore can the Dene of Flexely be placed, but at the forest in which it was situated, and from which it derived half of its appellation? And what pretence can a Dene in Hampshire, or a Dean in Lancashire, have to a place in a record, which relates only to the abbey of Saint Mary de Dene, in the forest of Dean? But all such reasonings are unnecessary: the point is ascertained beyond the possibility of a doubt, by Henry the Second's confirmation of the original

(2) Tanner's Notitia, p. 147.

(3) Atkin's Gloucestershire, p. 288. Edit. 1768.

grant,

grant, which may be seen below (4). The king, by this record, confirms to the monks, *locum qui dicitur Flexleia*

- (4) Flexleyenſis Abbatia, in agro Glouceſtrenſi. Carta Henrici Normannorum Ducis, Donatorum conceſſiones recitans et confirmand.

H. Dux Normanniæ et comes Andegaviæ archiepiſc, &c. Salutem. Sciatis me conceſſiſſe et confirmaviſſe Deo et Sanctæ Mariæ, et monachis ordinis Cifterciensis, pro ſalute antecellorum meorum, et mea propria, in elemoſinam perpetuam, omnes illas donationes quas Rogerus Comes Herefordiæ eiſdem monachis in elemoſinam dedit, juxta teſtimonium cartarum ſuarum, ſcilicet, locum quendam in valle Caſtiart, quæ dicitur Flexleia, ad conſtruendam abbatiam, et totam terram illam quæ dicitur Waſtadene, quæ fuit Wulfrici, et quandam fabricam ferrariam apud Edlandam, et totam terram ſub veteri Caſtello de Dena ad ſartandam, et illam quæ eſt aſſartata, et quandam piſcariam apud Redliam, quæ dicitur Newerra; et quoddam pratum in Pulmede, et omnia aſſiamenta ſua in foreſta de Dena, et domnicum totum de Dimmoc, et terram illam quæ fuit Uthredi clerici, et terram Ernaldi, et terram Wulfrici, ita ſcilicet, quod ipſe Uthredus clericus remaneat in manu abbatis, cum eſcambio ſuo, ſcilicet duabus virgatis terræ quod nemini inde reſpondeat niſi abbati; et dimidium nemus apud Dimmoc; et ſingulis annis *totam decimam Caſtaneorum de Dena*, et terram illam quam adquietavit ipſe Comes Herefordiæ de Gaufrido filio predicti Wulfrici, et aliam quam ipſe Comes adquietavit de Leſfrico, de Strattra. Quare volo, &c. Nos autem has prædictas donationes non tantum eis confirmo, ſed etiam omnes alias quas idem Rogerus Comes Herefordiæ illis in elemoſinam daturus eſt. Teſtibus Rogero Comite Herefordiæ, Willielmo de Crivecuer, Ricardo de Humet, Conſtab. Philippo de Columbariis, Roberto de Ivigum, Willielmo de Angervill, Willielmo Cumini, apud Eveſham.

Cart. Antiq. X. Num. 4.

Carta regis Henrici Secundi.

Henricus, Dei gratia, Rex Angliæ, et Dux Normanniæ et Acquitanniæ, et Comes Andegaviæ, Archiepiſcopis, &c. et omnibus fidelibus ſuis Angliæ et Normanniis, tam præſentibus, quam

Flexleia ubi abbatia fundata est, by the title of *Locum quendam in foresta de Lenā*. He afterwards goes on, to

quam futuris, salutem. Sciatis me dedisse et confirmasse Deo et Beatæ Mariæ et Monachis meis de Dena, quos in propria protectione suscepi, pro salute mea et antecessorum meorum, in elemosinam perpetuam, locum quendam in foresta de Dena, videlicet, totam vallem de Castiard, et locum qui dicitur Flexleia, ubi abbatia fundata est de ordine Cisterciensi, in honore beatæ virginis Mariæ, pro amore Dei, et pro anima regis Henrici avi mei, et Comitis Gaufridi Andegaviæ patris mei, et Matildis imperatricis matris meæ, et aliorum parentum et antecessorum meorum, et pro salute mea, et hæredum meorum, et pro stabilitate et pace regni Angliæ. Concessi etiam eis et confirmavi omnes illas donationes quas Rogerus comes Herefordiæ eisdem in elemosinam dedit sicut cartæ ejus testantur. Præterea dedi eis et confirmavi omnia aïsiamenta in eadem foresta mea de Dena, scilicet pasturam juvenis suis et porcis suis, et omnibus aliis pecoribus suis, et ligna et materiem ad domos suas et ad ædificia sua facienda, et ad alias res usui suo necessarias, sine vasto in eadem foresta mea. Et de eadem foresta dedi eis *decimam castaneorum meorum*, et grangeam quæ dicitur Wastedena, et unam forgeam ferrariam, ita liberam et quietam et operantem, per omnia, sicut meæ dominicæ forgeæ. Et totam terram sub veteri castello de Dene ad sartandam, et illam quæ est assartata; videlicet, centum acras, et quandam piscariam apud Reidleiam, que dicitur Nolwerā, et quoddam pratum apud Reidleiam, quod vocatur Pulmede; scilicet quatuor acras, et terram quam illis dedit in elemosinam Leuvericus de Staura, et grangiam quam eis dedi apud Wallemere, de assartis meis; videlicet, ducentas acras, cum pratis et pascuis, et omnibus aliis aïsiamentis, et quatuor acras de Northwoda, et totam dominicatum meum de Dimmoch, et quinque virgatas terræ et dimidium, præter dominicatum, et dimidium nemus meum de Dimmoch, et dimidium retium in manu mea; propter aïsiamenta hominum meorum, ea scilicet de causa, ut monachi mei habeant suam partem nemoris in bene et in pace, et sine omni communione aliorum hominum; et firmiter præcipio, ut nullus eos super hoc inquietet. Præterea dedi eis essartum quoddam subtus Castiard, quod vocatur Terra Vincentii. Hæc omnia dedi

to give them *omnia afiamenta in eadem foreſta mea de Denā*; and then he particularly ſubjoins, *et de eadem foreſta dedi eis Decimam Caſtanearum mearum*. Can any words poſſibly be more explicit than theſe? And can Mr. Barrington aver againſt the teſtimony of an authentic record? But, though the Dena of the record does mean the foreſt of Dean, Mr. Barrington has ſtill an objection in reſerve; and aſſerts that “there are not the leaſt veſtiges of any ſuch trees in “this foreſt at preſent.” (p. 29.) But is Mr. Barrington ſure there are no veſtiges of cheſnut trees in the foreſt? Did Mr. Barrington inſpect into every part of this ample area? And did no trees, no ſtumps, no ſtools, eſcape his eye in this wide unbounded range? But the fact appears otherwiſe. There are not merely ſtumps, not merely ſtools, of cheſnut trees; but actual and abſolute trees of cheſnut exiſting at this day, in the foreſt of Dean.

In a letter to me, dated Dec. 10, 1770, from the Rev. Mr. William Crawley, reſident at, and miniſter of Flaxley (uncle to Thomas Crawley Bovey, Eſq; the preſent owner of Flaxley abbey); is the following account:—“In this very foreſt and “near Flaxley is a parcel of land, about three or

dedi Deo et beatæ Mariæ et monachis meis Deo devote ſervientibus, habenda et tenenda imperpetuum, ſoluta et quieta ab omni reguardo et exactione ſeculari. Quare volo, &c. Teſte Ricardō de Humet, Willielmo de Creveca, Philippo de Columbariis, Willielmo de Anzervill, apud Eweſham. (Monastiicon Anglicanum, Tom. I. p. 884).

Pat. 22 R. II. part 3. m. 16. per Inſpex. Vide Cart. antiq. N. N. 30. Et pat. 27 H. VI. par. I. m. 9.

“ four hundred acres, which is still denominated
 “ *chesnut* : though neither chesnut, nor any other
 “ kind of tree is to be seen there, excepting what
 “ we call underwood or coppice, mostly hazel. In-
 “ deed in many places of the forest, I find chesnut
 “ trees are (sparingly) to be met with ; but within
 “ a few yards of the above spot, in a wood of my
 “ nephew, are many of remarkable fine growth.”
 But, even if the fact had been as Mr. Barrington hath
 stated it, the faith of a record attesting the existence
 of chesnut trees formerly, in the forest of Dean, was
 surely not to be superseded by the non-existence of
 such trees at present ; they might have existed former-
 ly, though they do not exist at present. And the
 record explicitly assures us that they did exist, and
 as early at least as the reign of Henry the Second.

The chesnut tree, therefore, may still claim a na-
 tural relation to this island, notwithstanding the two
 arguments of Mr. Barrington against it : and if we
 look into this kingdom, we see the chesnut tree, not
 confined to Sittingbourne woods, or to Dean forest ;
 but scattered with a free hand, through many parts
 thereof ; shooting up with all the healthy vigour of
 genuine natives, and giving denomination to several
 places amongst us. Thus the chesnut wood of Sit-
 tingbourne, has given the name of Chesnut-street,
 to the neighbouring road ; and the old Saxon half
 of the name, Street, strongly intimates the other half
 to be very ancient. The appellation occurs in the
 first map, that notices the names of the roads, the
 map of Kent by Morden. In Hertfordshire is a
 town, called in old writings, Cheston, Chesthunte,
 Shesterhunte, and Cestrehunt ; and Norden (in his
 description

discription of Hertfordshire, p. 15,) says, Cur non (5) Cher^uin? Castanetum of Chesse-nut trees?

The Saxons were well acquainted with this tree, and, according to Skinner and Lye, called it Cýrzel and Cýrz-beam; the same word evidently with our present Chef-nut. Dr. Johnson, in his *Mercurius Botanicus*, 1634, remarks the chesnut to have been not unfrequent in the woods, as well as in the plantations, of his own times; *Castanea Vulgaris in sylvis nonnullis et viridariis*;—Mr. Dale, in his *History of Harwich*, mentions various chesnut trees to be growing in Stour wood, within the parish immediately adjoining to Harwich. Blackstone, in his *Specimen Botanicum*, p. 12. speaks of chesnut trees growing in (6) Bulwin woods, between Dartford and Bexley, in Kent, plentifully; not twenty miles distant from London. Mr. Philipot, in his *Villare Cantianum*, which was printed in 1659, says in p. 237. “There is a manor, called Northwood Chasteners, which name complies with the situation; for it stands North from the town, in a wood where chesnut trees formerly grew in abundance.” “The noble chesnut tree, says Morton, (Northamptonshire, p. 397.) belonging to the Worshipful Thomas Tryst, Esq; of Marford, is the largest of that kind I have any where seen: the body of it is no less than fifteen feet eight inches in circumference; and it extends its branches proportionably.” “On the outside of the Roman station at Temple Brough, near Sheffield, in Yorkshire, says Gibson’s Camden, (Vol. II. p. 847.) “is a large bank, upon which are huge trees, and upon the side of the bank of the highway,

(5) Chertin.

(6) Now Baldwyn Woods.

U 2

“there

“ there grew a chesnut tree that had scarce any bark
 “ upon it, but only upon some top branches which
 “ bore leaves ; it was not tall, but the bole could
 “ scarcely be fathomed by three men.” “ There was
 “ standing, says Evelyn (in his *Sylva*, Fol. London,
 “ 1706, p. 223.) an old and decayed chesnut at
 “ Fraiting, in Essex, whose very stump did yield
 “ thirty sizeable loads of logs. I could produce you
 “ another of the same kind in Gloucestershire, which
 “ contains within the bowels of it, a pretty wain-
 “ scotted room, enlightened with windows, and
 “ furnished with seats, &c.” And to these we may
 add two great chesnut trees flourishing at Tortworth,
 in Gloucestershire, and at Writtlepark, in Essex ; the
 former is allowed, even by Mr. Barrington, “ to be
 “ the oldest tree that we have any account of, per-
 “ haps in Europe.” (p. 30.) And the following de-
 scription of both, was published about twelve or
 thirteen years ago (7) ; “ At the seat of the Lord
 “ Ducie, at Tortworth, in Gloucestershire, there is
 “ now growing an English chesnut, which measures
 “ fifty one feet about, at the height of six feet above
 “ the ground. This tree divides itself, at the crown,
 “ into three limbs, one of which measures twenty
 “ eight feet and half in the girt, and five feet above
 “ the crown of the tree. The soil is a soft clay,
 “ somewhat loomy ; the situation is the North West
 “ side of a hill ; this tree was stiled, in King John’s
 “ time, the great and old chesnut tree at Tortworth ;
 “ so it is supposed to be now above one thousand
 “ years old.”

(7) London Magazine, 1758, p. 482.

“ There

“ There is another stately chefnut (8), but little inferior to that at Torteworth, in Writtle park, three miles to the left of Ingatestone, in Essex. The late Lord Petre measured this tree, and found it forty five feet girth, five feet from the ground; this vast trunk supports a lofty head, which, at a distance, affords a noble prospect, and well deserves to be surveyed by all that admire such wonderful productions.” At Little Wymondley, near Hitchin, in Hertfordshire, is an old decayed chefnut tree, the trunk whereof (measured within these two years) was found to be forty two feet circumference in one part, and forty eight feet in another, as I am credibly informed.(9) And, to give additional force to an argument which is already decisive of itself, we may observe, that in the New Forest, there are very many chefnuts irregularly scattered among the oaks and other trees; and now to be seen in the road from Limington to Southampton.

In this great abundance of chefnut trees formerly among us, we need not wonder that chefnut timber was frequently used in old houses, preferable to oak; it was then the timber most esteemed by our joiners and carpenters. And, though very lasting, yet it has been justly discredited, in these later ages, for houses, because, when it begins to decay, the consumption commences at the core, and the heart is the first destroyed. And we can produce some

(8) In a News Paper, called The Citizen, or General Advertiser, Sept. 21. 1758.

(9) This tree is situate in the grounds, and near the house of Little Wymondley Bury, late the estate of Lord Grosvenor, but purchased within two or three years by Col. Cracherode.

proofs, additional to the many that have been formerly produced, of chesnut timber actually employed in buildings. "The old houses in the city of Gloucester (as the Reverend Mr. Crawley informs me that he has often been assured) are constructed of chesnut, derived assuredly from the chesnut trees in the forest of Dean." In many of the oldest houses at Feversham is much genuine chesnut, as well as oak, employed. In the nunnery of Davington, near Feversham (now entire), the timber consists of oak intermingled with chesnut. And the great chesnut beam which supported the leads of the church tower at Feversham, when it was lately taken down, was found rotted for many feet at the extremity; and had, as it were, a mere shell of sound timber remaining about it.

Thus have I endeavoured, with all the respect due to genius and truth, to point out some of the mistakes into which, I apprehend, Mr. Barrington has fallen. I might have dwelt more largely upon the antiquarian part of my subject; but the botanical was more immediately my point. And in the examination of this, I have shewn, that the chesnut tree flourishes greatly in this kingdom; that it appears wildly scattered over the face of the country; that it was actually settled among us many centuries ago; and used by our ancestors in buildings; and that it was even familiarly known to the Saxons. All these united evidences strongly co-operate to prove it a native of this island, and must absolutely be allowed to prove it, till Mr. Barrington, or some other person, can produce superior evidence to the contrary.

I beg

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I beg leave to submit these observations to your
considerations ; and have the honor to remain,

S I R,

Your most faithful

Humble servant,

Doctors Commons,
Jan. 5, 1771.

And. Coltee Ducarel.

XVIII. *Copy of Mr. Thorpe's Letter to Dr. Ducarel, concerning Chestnut Trees.*

Dear Sir,

Read March 8, 1771. **H**AVING perused the Hon. Mr. Barrington's letter to Dr. Watson, published in the Philosophical Transactions, I find he lays down three or four general rules to determine whether a tree is indigenous or not in any country, as follows :

“ I. They must grow in large masses, and cover
“ considerable tracts of ground; nor must such woods
“ end abruptly by a sudden change to other trees,
“ except the situation and strata become totally
“ different.

“ II. If the trees grow kindly in copses, and
“ shoots from the stool, it must for ever continue in
“ such a wood, unless grubbed up, nor is it then
“ easily extirpated.

“ III. The seed must ripen kindly : nature never
“ plants but where a succession may be easily con-
“ tinued, and in the greatest profusion.

“ Lastly, many places in every country must re-
“ ceive their appellation from indigenous trees, which
“ grow there, &c. When the instances of this are
“ singular,

“ singular, it will prove directly the contrary, as he hopes to shew with regard to the chesnut, &c.”

In answer to his objections, and agreeable to these his forgoing rules ; I shall endeavour to prove the chesnut to be an indigenous tree, in this island ; and 1st, Mr. Barrington says, that he examined the woods near Sittingbourn himself ; “ and on a very minute inspection of them, found those parts which consist of chesnuds, to be planted in beds or rows, about five yards distant from each other ; nor are there any scattering trees to introduce them, &c.”

In what wood or woods, he observed these plantations, I must confess, I am quite at a loss to find, having never observed this regularity in any of the woods I have been in ; and I very lately asked a person who has lived many years in that neighbourhood, deals largely in timber and underwood, and is over all these woods every year, who told me he knew of no such regular plantations in any of them ; that the chesnut grew intermixed with other trees, as in all ancient woods.

Indeed, the amazing distance of the plants from each other, which Mr. Barrington mentions, is somewhat extraordinary ; as the usual custom now, in planting sets of chesnut or ash, for hop poles, is about seven or eight feet distance, as has been lately done by John Cocking Sole, Esq; in his plantation of chesnuds, at Newington.

The woods, called the Chesnut woods, the property of the Earl of Aylesford, which lie in the parishes of Newington, Borden, and Bobbing, abound with these trees, which grow promiscuously with others, both from stubs and stools of a large size ;

twenty acres of which are annually felled for poles, &c.

Cranbroke Wood, belonging to Mrs. Mercer, in Newington, has the chefnut in plenty with other trees, which produce poles in abundance, from old stubs and stools.

The Squirrel Wood, the property of the Hon. Mr. Roper, in the parish of Stockbury; those called Long Tun and Binbury, contain plenty of chefnut, intermixed with other trees, in which are very large chefnut pollards; to appearance some hundred years standing; which grow on a poor soil, and are quite hollow shells, having no nourishment but from the rind or bark; yet throw out plenty of shoots from the roots.

I have a farm in the parish of Stockbury, called Nettlested, forty acres of which are tithe free, which portion of tithes belonged to the great monastery of St. Austin, situated without the walls of Canterbury. They were given in very ancient times to the use of the almonary or almonry of that abbey; as far back as the time of Archbishop Walter, in the year 1193, how long before is uncertain, and are mentioned by William Thorn, a monk of that house, and published by Sir Roger Twisden, in the Decem Scriptores; part of these tithes are woodland, and to this day called Almery or Ambry-Tanton. In this wood are very old stools of chefnut, some of which are ten feet circumference, and stand promiscuously with oak, ash, and other trees. These stools yet produce very good poles, which were felled once in my father's time, and have twice since they have been in my possession.

In short, all that vast range of woods, called Stockbury vallis, which extend from Key-street to Binbury Pound, produce the chefnut in common with other trees; the woods formerly belonging to the abbey of Lesnes, founded by Richard de Lucie, chancellor and chief-justice to Henry II. in the parish of Earith, still called the Abbey woods, having great plenty of chefnut, both timber and stub wood, and from the stumps and stools of large timber trees formerly felled, which stools are now quite hollow and decayed, except the outward bark or shell, round the crowns of which arise many stools, and are cut for poles at the proper growth.

Church wood, in the same parish, has the like; and many others in this neighbourhood.

In Wrotham parish above Kemling, is a wood belonging to a farm, called Cottons, which has chefnut intermixed with other trees.

I could enumerate many more in different parts of this county, was it necessary; and I make no doubt, on due inspection, the like may be found in other counties of this kingdom: it is most certain, the chefnut does not grow in every wood, but in such only, where the soil is adapted to it. Different strata will produce different trees; as for example, the great wood called Jordens, in the parishes of Bexley and North Cray, the woods beyond Ruxley towards Farningham, have some acres nothing but birch, some only hazel, &c. Golden-wood, in the parish of Seal, is intirely birch. The woods on the Cold hills, of Chelsfield and Nookholt, run most upon beech; and those in the Weald of Kent, upon a clayey soil, are chiefly oak.

In answer to the third and last general rule ; that the nuts of the chesnut tree ripen kindly, and in great quantity, is manifest from the numbers of poor people at Earith, and the adjoining hamlet ; going into the woods at the proper season, and gathering some a quarter, others three sacks each, to fat their hogs, especially when pulse and grain are dear. It is true, the nuts are not so large as on trees which stand single and open to the sun, in parks, courts, &c. Even the oak will not produce acorns in a wood, till it becomes an old tree ; and then not so large and in such plenty as on old trees and pollards which stand open in fields and hedge rows. But where the chesnut, as before observed, stands single and planted for ornament, as in the Wilderness park, the seat of Mr. Prat, in Seal ; and in Bradbourn park, the seat of Sir Roger Twilden, Bart, at East Malling, and divers other places, the nuts are large, well tasted, and in great plenty, yielding excellent food for the deer.

It is well known that trees close planted in orchards will not produce fruit so large and fair, as in kitchen gardens, where they stand single, are often digged about, and manured.

Mr. Barrington himself says, Dr. Watson informed him, " that in Spain the chesnut trees destined to " produce the best fruit, are engrafted upon the " wild chesnut ; and that the French call the com-
" mon sort Chataignier, and the improved one
" Maronier." If so, the latter may be the sort which are annually brought to England, and sold at all the fruit shops, &c. and are called Spanish chesnut. Mr. Barrington says, " the very name of Spanish,
" seems

“ seems most strongly to indicate the country from which this tree was introduced here.” But why Spanish? I do not know that it is any where here so called, and none of the wood-men know it by that name. The old Botanical writers, John Bauhine, Gerhard, and Parkinson, call it *Castanea Vulgaris*. Caspar Bauhine, in his *Pinax*, *Castanea Sylvestris*, the common or wild chestnut tree. Ray indeed, in his *Synopsis*, the 3d Edit. published by Dillenius, p. 449, has the following, “ in sylvis quibusdam prope
 “ Sittingburn Cantii oppidum, & Woburn Bedfordiæ,
 “ observavimus an spontaneam, an olim ibi fatam, nescimus.” It is somewhat strange that so celebrated a Botanist should treat of it in so slight a manner, and with seemingly so little attention, as to mention it only in those two places.

Lastly, Mr. Barrington says, “ that many places, in every country, must receive their appellation from indigenous trees which grow there, &c.”

There are many trees which give few, if any, appellation to places. It does not therefore follow that they are not indigenous. In ancient time, England abounded more in woods and forests than at present; and the oak and ash being then two of the most common trees, occasioned the names of the contiguous places and parishes to receive their derivation.

Notwithstanding his trial of the specimens of oak and chestnut, I am well assured many old buildings were, and are, of the latter; especially in places where these trees flourished. When I repaired the old house at Nettlested, in Stockbury, in sawing off the end of the main girder, it was decayed at heart; and

and pronounced by the surveyor and carpenter then present to be chefnut, as are the other timbers.

Cowsted, a very ancient seat in the same parish, is intirely of that wood; and Dr. Stukely, in his letter to the late Lord Hardwick, read at the Society of Antiquaries, and since published in the *Archæologia*, p. 44. says, “the curious roof of the large hall “of the mansion house at Lesnes is of chefnut, which “no doubt was felled in the abbey woods there.”

In latter times, the seat called Mount Mascall, in the parish of North Cray, rebuilt by Sir Comport Fitch, Bart. about fourscore years since, the girders and large timber of which are, as I am well informed, of chefnut felled in the woods adjoining.

And why should it not have been used in buildings, seeing it is very durable, and grows to a great size? witness the fine trees felled last summer, together with some oak and beech, in the park of Penshurst in this county; possibly in length of time, the characteristick of the chefnut trees decaying inwardly, might be the reason of the oaks being mostly used, as the more durable timber; and the former found to turn to better account for underwood and poles; especially when hops came into use in Henry the Eighth's time, and are the best for that purpose. Even oak, by reason of its scarcity and dearness, is now little used in publick buildings; fir-timber altogether supplying its place.

The chefnut tree yet alive in the court at Tortworth, in Gloucestershire, supposed by Evelyn and Bradley to have been planted in the time of King John, may possibly be the oldest tree of the kind extant in this kingdom; but is no proof of there not

not being chefnut trees before that time: Any more than the famous tree called Bears oak, in the park at Penshurst abovementioned; or the well-known tree called Fisher's oak, in the parish of Farnborough, in this county; or that in Welbeck park, the seat of the Duke of Portland, were some of the first trees of that kind here planted; the situation and ornament of these trees protected them from the axe.

The common elm, Evelyn thinks not to be an indigenous tree, and it may not as it is seldom, if ever, found growing in woods; but in road ways, hedge rows, &c.; and not in the North of England, though, as Mr. Ray observes, some trees are only found in the North, some in the South, and others in the West; neither does the elm, when an old tree, shoot kindly from the stool.

I agree with Mr. Barrington, that the box tree is an exotick; but the yew is certainly indigenous, as I think may be easily proved, and which he assents to, but doubts whether the euonymus or spindle tree, and ligustrum or privet, are so; most certainly they are, as no shrubs are more common on dry banks, and in hedges, &c.: but, as he assigns no reason for their not being indigenous, I shall dwell no longer on that subject, and conclude,

Dear Sir,

Your most humble servant,

Bexley,
Nov. 26. 1770.

J. Thorpe.

XIX. *Extract of a Letter from Edward Hafted, Efq; F. R. S. and F. S. A. to Dr. Ducarel, concerning Chefnut Trees.*

Dear Sir,

Read March 8, 1771. **I**N answer to Mr. B's 1st rule—I must remark, instances are exceeding frequent of woods and coppices breaking off, by a sudden change, to other trees, and that where the situation and strata are entirely the same; sometimes without any mark of division, and sometimes with a ditch only, an old stub for a boundary, or perhaps distinguished only by the difference in the growth of the underwood, or the like. It is a known fact, that particular sorts of trees have grown in large tracts and masses in a country, which have been in succeeding times almost extirpated from thence, either from others being more diligently encouraged and preserved, or from the present destructive method of too frequent cutting them down; and only scattered stubs or trees have remained of the sort, thinly dispersed in woods and hedges. The wick, elm, maple, and others, are indigenous trees; and yet seldom, if ever, grow in large masses, or cover considerable tracts of ground; the reason of which

which is, they never shoot from the stool so as to make any considerable progress.

As to the 2d—A tree, or particular wood, may grow very kindly in a coppice, and yet in process of time, by the continual felling of the wood, may be entirely worn out, when other sorts, which bear the woodman's cutting-bill more kindly, will increase, and overrun the former, so as to fill every vacancy made by it. Besides, there are some kinds of wood which are poisoned, and in time decay by the near affinity of others. The ash is a particular instance of this poisonous quality towards other trees.

As to the 3d rule of seeds ripening kindly; I must disagree in this too, as I find very few, if any, whether indigenous or not, whose seeds do not ripen here sufficient to continue the tree easily; and where it is not in profusion, the indigenous tree will be found as deficient as some others, which are known to be otherwise.

Mr. B's last rule, of places taking their name from indigenous trees which grow there, may serve as well to prove all trees whatsoever so: there being but few trees which have grown in Britain, but our very ingenious etymologists have derived the names of some places from them.—Singular instances, I own, I do not recollect.

All kinds of things in general adopt the name of that country where they grow, or are made in the greatest perfection.—Instances of this are obvious in every necessary of life. The chestnut, whose fruit ripens in Spain in much more perfection than in this variable and colder climate, has gained the additional name of Spanish to it, among the merchants

and venders of them, though in the country villages the woodmen will yet talk of the growth of this right ENGLISH CHESNUT. And as to Pliny's telling us that chesnuts were brought from Sardis to Italy long before his time; that does not make it less probable that they might have been the growth of Britain, at the very time they were brought from thence to Rome.

The ancient Norman buildings are mostly of this wood, which in all probability was fetched from this country; most of the stone wherewith our monasteries and buildings of such sort were erected came from Normandy. This seems to have been a mutual traffick for some centuries between the two countries.

How the notion arose first, that the forest mentioned by Fitz-Stevens to the Northward of London, was mostly of chesnut, I do not know, nor could I ever find any authority for it; though it continues the assertion of most literary men. If I might conjecture, I should think it to have arisen from a blunder and mistake of the name of Norwood; there being many decayed stubbs of chesnuts in the archbishop of Canterbury's Norwood, not far from London; which is, no doubt, the place Mr. Miller means, when he mentions such having been seen in the neighbourhood of the metropolis.

Most antiquarians assert that Old London was built of chesnut; that this tree grew near London, has been proved above from Norwood, and may from the name of Cheshunt, in Hertfordshire; that it may have done so in former times in great plenty, might be supposed from what I have said before; but one

reason of its decay may be assigned to the great increase of the metropolis, which consumed most of the chesnut timber near it; and the stubbs of such being much subject to decay, few, if any of them, could naturally last to this time, so as to bring any profit to the owner, but have been grubbed up from time to time, till they are now almost totally eradicated; and I think, there is great probability that the universal decay and destruction of this kind of timber, throughout the realm, appeared in so serious a light to the legislature, as to give the first rise for our laws for the preservation of timber in general.

Oak timber is so entirely different from chesnut, in the rings and spaces, which appear when cut transversely, that it is impossible to mistake the one from the other.

In a note, p. 96. of the Anglo-Norman antiquities, mention is made, of a large tract of chesnut woods, near Sittingbourne, in Kent (and in the North West part of East Kent, as it should be printed), which is certainly right; these woods are a very large tract, which more or less have chesnut stubbs spread over the whole space of them. They extend some miles, from the environs of the town of Milton, by the old highway (now disused), leading from thence to Maidstone. The general name of the whole tract, is Chesnut or Chestney Woods. The 40 acres mentioned in the said note to have been grubbed up, were only felled; and were of such a size and growth, as to be mostly used as timber. On the top of Chesnut Hill between Newington and Sittingbourne, there stood a chesnut tree of prodigious size, which has been felled within these few

years, the stool of which may now be seen close to the high road.

The production of nature in this vast tract of woods is so plain, that it would be absurd to use arguments to defend it; nor shall I bring examples of it from other countries, which might be had: I shall only take notice, with Dr. Ducarel, that in the ancient forests of Kent, which lay to the south of it, adjoining to Suffex and Surry, there remain large old chesnut stubs or brocks, now almost worn out, and perished, which are left by the woodmen as termini or boundaries, either of parishes or of private property; which is the universal custom every where made use of to distinguish the wood of different owners, and are never cut down or altered; so that they must have stood sacred to this use, from the first introduction of private property into this island; and were no doubt even then of considerable age, by their being made choice of for this use, in preference to any others.

But to return to the neighbourhood of Milton.—The manor of Norwood, within that parish, is called, in the highest records we are acquainted with, Norwood-Chestney, Chastney, and Castney, no doubt from the great plenty of chesnut within its bounds, even in those early times. Nor is this a singular instance of any place in England being named from the chesnut tree; Cheshunt, in Suffolk; and Cheshunt, in Hertfordshire, having both their names from the plenty of chesnuts near them: the last of these places, Chancy tells us, seems in old time to have abounded with them; and that most of the ancient houses in that vill were built of them; and in the venerable

nerable book of Doomsday, we have an account of a quantity of woodland in this parish, sufficient for the feeding of 1200 hogs, which shews us that this considerable tract of wood was of such sort, as to afford plenty of good food for swine; as it certainly must be to afford pannage for so large a number; and that these woods were chefnuts, may in all probability be presumed from the above circumstances.

The same venerable record likewise mentions the village of Box, alias Boxbury, in Hertfordshire; which, the learned Serjeant tells us, was so called from a large wood, which retains the name to this day; and I have now before me the names of more than a dozen parishes and places, which have taken their names from the box tree, and retain it to this time. The fir, no doubt, from every evidence that can be had of former times, and by the evidence of our own eyes, from the numbers of them which have been dug up in almost every part of Britain, was an indigenous tree of this county; notwithstanding Cæsar's assertion to the contrary, who appears to have been but little acquainted with it, when he tells us, "this island had every kind of tree the same as Gaul, except the fir and the beech;" both of which were in the greatest plenty here at that very time; the latter was particularly so within the county of Kent, the only spot he might be said to be acquainted with: and yet, after this, no one sure will assert that either of these trees are not indigenous; though the former of them is entirely extirpated (as the production of nature) from the Southern part of Britain, which the chefnut is not; though it is made use of as an argument against
its

its being the natural product of this country. The elm bears every mark of its being indigenous; and, according to one of Mr. B's general rules, it must be so, for there are near 40 places in England, which take their name from this tree, most of which are mentioned in the book of Doomsday.

Whoever has been much acquainted with the woods and tracts of ground lying on our Chalky Hills, will surely never contend that the yew is not the indigenous growth of this country. I am,

Dear Sir,

Yours, &c.

Huntingfield, in Kent,
Nov. 29, 1770.

Edw. Hafted.

XX. *A Letter from the Hon. Daines Barrington, F.R.S. to Mathew Maty, M.D. Sec. R. S. occasioned by the three preceding Letters.*

DEAR SIR,

February 15, 1771.

Read March 8, 1771. **I** HAVE lately had an opportunity of perusing three letters from Dr. Ducarel, Mr. Thorpe, and Mr. Hafted, which contend that the sweet chesnut is an indigenous tree of this country, and which are intended to be communicated to the Royal Society.

As I do not see any reason for altering the opinions which I have happened to form on this subject, from what is contained in these three letters, I should not trouble the Society with any answer to the contents of them, did not Mr. Thorpe contradict, on the testimony of another person, what I have asserted I was an ocular witness of.

I must therefore a second time repeat, that the chesnut woods near Newington, in Kent, are planted in rows at four or five yards distance (other trees often intervening); and for a proof of this fact, I refer Mr. Thorpe to the woods on the North East of the church;

church* ; as also the wood to the eastward of the great road to Canterbury, immediately after you leave the town of Newington.

I spent very near a whole day in the examination of these woods ; but I would more particularly refer to the two chesnut plantations above specified, as they were just then shooting from the stools, when I took this very minute view of them.

I have already said, that I am willing to leave the point in controversy, upon what hath been advanced on the one side, and on the other.

I will only beg leave to state a single observation, together with what seems to be an inference that is fairly deducible from it, and which is applicable to any disputes, with regard to trees being of native growth, or otherwise.

I believe I may say, that I have been almost in every corner of the twelve Welsh counties ; and never saw a beech tree in any of them, which had the least pretence to be indigenous.

I will suppose, however, that a wood of any given number of acres, with beech in it, was found in the central part of the principality ; and that these trees were not planted in rows (as at Newington and Sittingborne) ; but dispersed, as happens in other indigenous woods.

Could it possibly be contended, that such beech trees had not been introduced by some planter ; notwithstanding it might be proved to be a wood of great antiquity ?

* I think, I can depend upon my memory so far, as to say that the chesnuts I have alluded to, are at the North East of the church ; but at all events, they are very near to it.

If this was infisted upon, it must at the same time be conceived, that when the beech mast was wafted by the wind to such a most selected spot, some preternatural cause must have prevented its being sown in any intermediate place.

I am, DEAR SIR,

Your most faithful

humble servant,

Daines Barrington.

Received November 15, 1770.

XXI. *An Account of the Nyl-ghau, an Indian Animal, not hitherto described:*
By William Hunter, M. D. F. R. S.

Read Feb. 28,
1771.

AMONG the riches which, of late years, have been imported from India, may be reckoned a fine animal, the Nyl-ghau; which, it is to be hoped, will now be propagated in this country, so as to become one of the most useful, or at least one of the most ornamental beasts of the field. It is larger than any ruminant of this country, except the ox; its flesh probably will be found to be delicious; and, if it should prove docile enough to be easily trained to labour, its great swiftness, with considerable strength, might be applied, one would think, to valuable purposes.

Good paintings of animals give much clearer ideas than descriptions. Whoever looks at the picture, which was done under my eye, by Mr. Stubbs, that excellent painter of animals (see Tab. V.), can never be at a loss to know the Nyl-ghau, wherever he may happen to meet with it. However, I shall attempt a description of the animal; and then give as much of its history as I have been hitherto able to learn. The account will be imperfect: yet it will give naturalists some pleasure in the mean time to know

know even a little of a large and elegant animal, which has not hitherto been described, or painted.

At first sight, the male Nyl-ghau struck my imagination with being of a middle nature, between black cattle and deer; such an animal as we might suppose a mule would be, that was the produce of those two species of beasts. In size, it is as much smaller than the one, as it is larger than the other: and in its form there is a very apparent mixture of resemblance to both. Its body, horns, and tail, are not unlike those of a bull; and the head, neck, and legs, are very like those of deer.

COLOUR. The colour, in general, is ash, or grey, from a mixture of black hairs and white: most of the hairs are half white, and half black; the white part is towards the root. The colour of its legs is darker than that of its body; the same thing may be said of its head, with this peculiarity, that there the darker colour is not general and uniform, but some parts are almost quite black. In some parts to be mentioned hereafter, the hair is of a beautiful white colour.

TRUNK. The height of the back, where there is a slight eminence over the shoulder-blade, is four feet and one inch; at the highest part, immediately behind the loins, it is only four feet. The general length of the trunk, as seen in a side view, from the root of the neck to the pendulous tail, is about four feet; which is nearly the height of the animal; so that, in a side view, when it stands with its legs parallel, its back and limbs make nearly three sides

of a square, and the ground upon which it stands makes the fourth.

Round the body, immediately behind the shoulder, it measures four feet and ten inches; and a little more just before the hind-legs; but this last dimension, no doubt, will vary considerably, as it happens to be more full or empty of food and drink.

HAIR. The hair on the body in general is thinner, more bristly, and stronger, than on our black cattle. On the belly, and upper part of the limbs, it is longer and softer than upon the back and sides.

MANE. All along the ridge or edge of the neck and back, as far as the posterior part of the hump which is over the shoulder-blades, the hair is blacker, longer, and more erect; making a short, and thin, upright mane.

The umbilical and hypogastric regions of the belly, the inside of the thighs, and all those parts which are covered by the tail, are white. The *præputium penis* is not marked with a tuft of hair; and the sheath of the *penis* projects very little.

TESTICLES. The testicles are oblong and pendulous, as in a bull.

TAIL. The bones of the tail come down to within two inches of the top of the *os calcis*. The end of the tail is ornamented with long black hair, and likewise with some white, especially on the inside. On the inside of the tail, except near its extremity, there is no hair; and on the right and left

left there is a border of long white hair, which makes it on the inside look like a feather.

LEGS. The legs are small in proportion to their length; more so than in our black cattle, and rather less so than in our deer. The length of the fore-leg is a little more than two feet and seven inches. There is one white spot on the fore part of each foot, almost immediately above the large hoofs; and another smaller white spot before the small hoofs: above each of the small hoofs, there is a remarkable tuft of long white hair, which turns round in a flat curl. The large hoofs of the fore-leg, are of an awkward length. This was very observable in every one of the five individuals of this species which I have seen; yet it was suspected to be the effect of confinement; and the examination of the hoof, in the dead animal, proved that it was so.

NECK. The neck is long and slender, as in deer; and when the head is raised, it has the double turn of the Italic letter S. At the throat, there is a shield-like spot of beautiful white hair; and lower down, on the beginning of the convexity of the neck, there is a mane-like tuft of long, black hair.

HEAD. The head is long and slender. From the horns, it rises upwards and backwards to join the neck. Its length, from the horns only to the point of the nose, is about one foot two inches and three quarters.

Nose.

Nose. The partition between the nostrils was artificially perforated for fixing a cord, or bridle, according to the Eastern custom of tying up or leading horned cattle. The nostrils are very long, in a direction almost parallel to the mouth, and are widest at their anterior end.

MOUTH. The *riktus oris* is long; and as far as this reaches, the lower jaw is white: so is the upper lip, as far as the nostril.

TEETH. There are six grinders in each side of each jaw, and four incisor teeth in each half of the lower jaw. The first of the incisors is very broad; and the rest smaller in gradation, as they are placed more outwards or backwards.

EYES. The eyes in general are dark coloured; for all of the *conjunctiva* that can be commonly seen is of that complexion. In an oblique or side view, the *cornea*, and all that is seen through it, is blue, like burnished steel. The pupil is oval, or oblong, from side to side; and the *iris* is almost black.

EARS. The ears are large and beautiful, above seven inches in length, and spread to a considerable breadth near their end. They are white on their edge, and on their inside; except where two black bands mark the hollow of the ear with a zebra-like variety.

HORNS. The horns are seven inches long; they are six inches round at their root, and growing
smaller

smaller by degrees, they terminate in a blunt point. At their root they have three flattened sides, divided by so many angles: one of the angles is turned forwards, and consequently one of the sides backwards. This triangular shape is gradually less perceptible towards the extremity. At the root there are slight circular wrinkles, in proportion to the age of the animal. The body and point of the horn is smooth, and the whole of a very dark colour. They rise upwards, forewards and outwards at a very obtuse angle, with the forehead or face. They are gently bended, and the concavity is turned inwards, and a little forewards. The distance between them at the roots is three inches and a quarter, at the points six inches and a quarter, and at their most hollow middle parts less than six inches.

FOOD. It eats oats, but not greedily; is fonder of grass and hay*; but is always delighted with wheat bread. When thirsty, it would drink two gallons of water.

DUNG. Its dung is in the form of small round balls, of the size of a nut-meg; and it passes a quantity of these together, with a rushing sound.

MANNERS. Though it was reported to have been exceedingly vicious, it was in reality a most gentle creature while in my custody, seemed pleased with every kind of familiarity, always licked the

* General Carnac informs me, that no hay is made in India; their horses are fed with grass fresh cut, and a grain of the pulse kind, called *Gram*.

hand which either stroked, or gave it bread, and never once attempted to use its horns offensively. It seemed to have much dependance on it's organs of smell, and snuffed keenly, and with noise, whenever any person came within sight. It did so likewise when any food or drink was brought to it; and was so easily offended with a smell, or so cautious, that it would not taste the bread which I offered, when my hand had touched oil of turpentine or spirits*.

Its manner of fighting is very particular: it was observed at Lord Clive's, where two males were put into a little inclosure; and it was related to me by his Lordship, thus: While they were at a considerable distance from each other, they prepared for the attack, by falling down upon their fore-knees; then they shuffled towards each other with a quick pace, keeping still upon their fore-knees, and when they were come within some yards, they made a spring, and darted against each other.

All the time that two of them were in my stable, I observed this particularity, *viz.* that whenever any attempt was made upon them, they immediately fell down upon their fore-knees; and sometimes they

* General Carnac, in some observations which he favoured me with upon this subject, says, "All of the deer kind have the sense of smelling very exquisite. I have frequently observed of tame deer, to whom bread is often given, and which they are in general fond of, that if you present them a piece that has been bitten, they will not touch it. I have made the same observation of a remarkable fine she-goat, which accompanied me most of my campaigns in India; and supplied me with milk, and which, in gratitude for her services, I brought from abroad with me."

would

would do so when I came before them; but, as they never darted, I so little thought this posture meant hostility, that I rather supposed it expressive of a timid or obsequious humility*.

FEMALE. The *Female* differs so much from the *Male*, that we should scarcely suppose them to be the same species. She is much smaller, both in height and thickness. In her shape, and in her yellowish colour, she very much resembles deer; and has no horns. She has four nipples, and is supposed to go nine months with young. She commonly has one at a birth, and sometimes twins.

The young male Nyl-ghau is like the female in colour, and therefore like a Fawn.

SPECIES. When a new animal is presented to us, it will often be difficult, and sometimes impossible, to determine its species, by the external characters alone. But when such an animal is dissected by an anatomist, who is a master in comparative

* The intrepidity and force with which they dart against any object may be conceived from the following anecdote, of the finest and largest of those animals that has ever been seen in England. The violence which he did to himself, was supposed to occasion his death, which happened soon after. A poor labouring man, without knowing that the animal was near him, and therefore neither meaning to offend, nor suspecting the danger, came up near to the outside of the pales of the inclosure; the Nyl-ghau, with the quickness of lightening, darted against the wood work, with such violence, that he broke it to pieces; and broke off one of his horns close to the root. From this piece of history and farther inquiry, I was satisfied that the animal is vicious and fierce in the rutting season, however gentle and tame at other times.

anatomy, the question is commonly to be decided with certainty.

From the external marks alone, I suspected, or rather believed, the Nyl-ghau to be a peculiar and distinct species. Some of my acquaintance thought it a deer. The permanent horns convinced me that it was not. Others thought it an antelope. The horns, and the size of the animal, made me suspect that it was not. It had so much of the shape of deer, especially the female, that I could not suppose it to be of the same species with our black cattle. In rutting time, one of the males was put into a paddock with a female of the red-deer: but nothing like attraction or attention was observed between them. At length, in consequence of the death of one of them, I was assured by my brother, who dissected it, and who has dissected with great attention almost every known quadrupede, that the Nyl-ghau, is a new species*.

HISTORY. Of late years several of this species, both male and female, have been brought to England. The first were sent from Bombay, by Gov. Cromelen, as a present to Lord Clive: they arrived in August 1767. They were male and female, and continue to breed every year. Afterwards two were brought over, and presented to the Queen by Mr. Sullivan. From her Majesty's desire to encourage every useful or curious enquiry in natural knowledge,

* Mr. Pennant, whose love of natural history heightens the enjoyment of an independent fortune, in his *Synopsis*, published since this paper was written, classes this animal (*White-footed*, p. 79.) as a species of the *Antelope*; but he now thinks it belongs to another *Genus*, and will class it accordingly in his next edition.

I was

I was permitted to keep these two for some time; which enabled me to describe them, and to get a correct picture made; and, with my brother's assistance to dissect the dead animal, and preserve the skin and skeleton. Lord Clive has been so kind to give me every help that he could furnish me with, in making out their history; so has General Carnac, and some other gentlemen.

At all the places in India, where we have settlements, they are rarities, brought from the distant interior parts of the country, as presents to Nabobs and great men. Lord Clive, General Carnac, Mr. Walsb, Mr. Watts, and many other gentlemen, who have seen much of India, tell me they never saw them wild. So far as I have yet found, Bernier is the only author who has even mentioned them*. In the 4th Vol. of his Memoires, he gives an account of a journey which he undertook, ann. 1664, from Delhi, to the province of Cachemire, with the Mogul Aurengzeb, who went to that terrestrial paradise, as it is esteemed by the Indians, to avoid the heat of the summer. In giving an account of the hunting, which was the Emperor's amusement in this journey, he describes, among others, that of *le Nylghau*; but without saying more of the animal, than

* Since the reading of this paper, I have received the following information from Dr. Maty. In the fourth Volume of Valentyn's description of the East Indies, published in Low Dutch, 1727, under the article of Batavia, p. 231, I find amongst the uncommon animals kept at the castle, this short indication, "There was a beast, of the size and colour of a Danish ox, but less heavy, pointed towards the mouth, ash-grey, and not less than an Elk, whose name he bore." It was a present from the Mogul.

that the Emperor sometimes kills them in such numbers, as to distribute quarters of them to all his Omrachs; which shews that they were there wild, and in plenty, and esteemed good or delicious food.

This agrees with the rarity of these animals at Bengal, Madrafs, and Bombay: for Cachemire is the most northern province of the Empire; and it was on the march from Delhi to that place, that Bernier saw the Emperor hunt them.

NAME. The word *Nyl-ghau*, for these are the component letters corresponding to the Persian, though pronounced as if it were written *Neel-gaw*, signifies a blue cow, or rather a bull, *Gaw* being masculine; and the male animal of that name has a good title to the appellation, as well from the likeness he bears in some parts to that species of cattle; as from the bluish tinct which is very discernible in the colour of his body; but this is by no means the case with the female, which has a near resemblance, as well in colour as in form, to our red deer. The *Nyl-ghaus* which have been brought to England have been most, if not all, of them received from Surat or Bombay; and they seem to be less uncommon in that part of India, than in Bengal; which gives room for a conjecture that they may be indigenous perhaps in the province of Guzarat, one of the most Western and most considerable of the Hindustan empire, lying to the Northward of Surat, and stretching away to the Indian ocean.

A gentleman * who has been long in India, and has an extensive acquaintance there, has written to

* General Carnac, who likewise favoured me with the preceding article upon the name of the animal.

his friends, to collect all the intelligence they can possibly procure concerning this animal; and in the course of the next year, some satisfactory information may perhaps be received from thence, though the natives of that country, he says, have no turn whatever after natural history; and indeed are very little inquisitive after any kind of knowledge.

XXII. *Observations on the Aphides of Linnaeus, by Dr. William Richardson, of Ripon, Yorkshire: Communicated by William Heberden, M.D. F.R.S.*

Read Mar. 14,
1771.

THE learned *Linnaeus* by his unwearied application having reduced the various productions of nature into one regular system, and clearly distinguished the numerous tribe of insects into their distinct classes and subdivisions, seems to me to have laid a more solid foundation for the natural history of these minute animals, than any other writer who has gone before him. Difficult, however, as it is to lay so firm a foundation, the superstructure must still be esteemed a more arduous undertaking; as it is easier to distinguish the outward form, even of the minutest insects, than to discover their internal nature and disposition. This is a knowledge not to be attained by any single person, be his genius and diligence ever so great; but to bring it to any degree of perfection, will require the joint endeavours of the curious in all ages, and in all the different parts of the world. From which considerations, I am induced to throw in my mite towards promoting so useful an undertaking; by reducing my observations on this surprizing kind of insect, into a more concise and regular form.

Though the Aphides are distinguished by Linnæus into more than thirty species; still I am satisfied, from my own observation, the distinct species are even double that number: nor can I altogether agree with this ingenious author, that there are a greater variety of plants producing Aphides, than there are different sorts of this insect. Where plants are of a like nature, they are usually frequented by the same insects; but many of these plants will be found to support two or more quite different sorts. On the peach and nectarine indeed the Aphides are the same, nor do I find on these trees more than one sort. The plum tree, on the other hand, has two sorts, very distinct from each other: one of a yellowish-green, with a round short body; the other of a bluish-green, as it were enameled with white, and the shape more oblong. On the gooseberry-bush and currant the same Aphides may be found; but each of these is inhabited by two very different species: one being of a dusky green, with a short plump body; the other of a paler green, the body more taper, and transversely wrinkled. To these instances I must further add, that the rose-tree supports not less than three distinct species: The largest of which is of a deep green, having long legs of a brownish cast, with the joints of a very dark brown, as are also the horns and antennæ; a second sort is paler green, has much shorter legs, and a more flat body; the third sort is of a pale red, its body transversely wrinkled, and is most frequently on the sweet-brier. It not being, however, so much my intention to enumerate the different species of these insects, as to give some insight into their extraordinary

nary nature; the instances I have already produced will, I flatter myself, be thought sufficient.

The great variety of species which occur in the insects now under consideration may indeed make an enquiry into their particular natures seem not a little intricate and perplexed; having them, however, skillfully reduced under their proper genus, the difficulty is by this means considerably diminished. All the insects comprehended under any distinct genus, we may reasonably suppose to partake of one general nature; and, by diligently examining any of the particular species, may thence gain some insight into the nature of all the rest. With this view I have chosen, out of the various sorts of Aphides, the largest of those found on the rose tree; not only as its size makes it the more conspicuous, but as there are few others of so long a duration. This sort, appearing early in the spring, continues late in the autumn; while several are limited to a much shorter term, in conformity to the different trees and plants from whence they drew their nourishment.

SECTION I.

If at the beginning of February the weather happens to be so warm, as to make the buds of the rose tree swell and appear green; small aphides are frequently to be found upon them, not larger than the young ones in summer, when first produced. But there being no old ones to be found at this time of the year, which in summer I had observed to be viviparous; I was formerly not a little perplexed by
such

such different appearances, and almost induced to give credit to the old doctrine of equivocal generation. That the same kind of animal should, at one time of the year be viviparous, and at another oviparous, was an opinion I could then by no means entertain. This, however, frequent observation has at last convinced me to be fact; having found those Aphides, which appear early in the spring, to proceed from small black oval eggs, which were deposited on the last year's shoots in autumn: though, when it happens that those insects make too early an appearance, I have observed the greatest part to suffer from the sharp weather that usually succeeds; by which means the rose trees are some years in a manner freed from them.

Those which withstand the severity of the weather, seldom come to their full growth before the month of April; at which time they usually begin to breed, after twice casting off their exuviae, or outward-covering. It then appears that they are all females, which produce each of them a very numerous progeny, and that without having intercourse with any male insect. As I observed before, they are viviparous; and what is equally uncommon, the young ones all come into the world backwards. When they first come from the parent, they are enveloped by a thin membrane, having in this situation the appearance of an oval egg; which I apprehend must have induced Reaumur to suspect that the eggs discovered by Bennet were nothing more than abortions. This egg-like appearance adheres by one extremity to the mother, while the young one therein contained extends the other; by that

means gradually drawing the ruptured membrane, over the head and body, to the hind feet. During this operation, and for some time after, by means of something glutinous, the fore part of the head adheres to the vent of the parent. Being thus suspended in the air, it soon frees itself from the membrane in which it was confined, and after its limbs are a little strengthened, is set down on some tender shoot, and then left to provide for itself.

When the spring proves mild, and consequently favourable to this kind of insect, I have observed not only the rose trees, but various kinds of fruit-trees, to be greatly injured by them. Hence I was first introduced to investigate the nature of these insects; in order to find out some expedient, whereby so great an evil might be prevented. To avoid being tedious by descending to particulars, I shall recommend the following general rule; *viz.* to lop off the infected shoots before these insects are greatly multiplied; repeating the same operation before the time their eggs are deposited. By the first pruning, you will prevent a very numerous present increase; and by the second, may intirely cut off the next year's supply.

SECTION II.

In the spring months, there appear on the rose tree but two generations of Aphides, including those which immediately proceed from the last year's eggs; the warmth of the summer adds so much to their fertility, that no less than five generations succeed each other during that interval. One is produced

duced in May, which twice casts off its covering; while the months of June and July each supply two more, which cast off their coverings three or four times, according to the different warmth of the season. This frequent change of the outward covering is the more extraordinary, as it is the ofteneft repeated when the insects come the soonest to their growth; which I have sometimes observed to happen in ten days, where warmth and plenty of nourishment have mutually conspired. From which considerations, I am thoroughly convinced, that these various coverings are not connate with the insect; but that they are like, the scarf-skin, successively produced.

Early in the month of June, some of the third generation, which were produced about the middle of May, after casting off their last covering, discover four erect wings, much longer than their bodies: and the same is observable in all the succeeding generations, which are produced during the summer months; without however distinguishing any diversity of sex, as is usual in several other kinds of insects. For some time before the Aphides come to their full growth, it is easy to discover which of them will have wings, by a remarkable fulness in the breast, which in the others is hardly to be distinguished from the body. When the last covering is rejected, the wings, which were before folded up in a very narrow compass, gradually extend themselves in a most surprizing manner, till their dimensions are at last very considerable. But these winged ones have this further peculiarity, that the number of them does not seem so much to depend on their

original structure, as on the quantity or quality of the nourishment wherewith they are supplied: it being frequently observable, that those on a succulent shoot have few or none with wings among them; while others of the same generation, on a less tender branch, are most of them winged: as if the first rudiments of the wings were composed in the former, while nature thought proper to expand them in the latter, that they might be more at liberty to supply their wants.

The increase of these insects in the summer time is so very great, that, by wounding and exhausting the tender shoots, they would frequently suppress all vegetation, had they not many enemies which restrain them. To enumerate the variety of other insects, that in their worm and fly state are constantly destroying them, would exceed the bounds of my present design: there is one, however, so singular in the manner of executing its purpose, that I cannot pass it by without some further notice. This is a very small black ichneumon fly, with a slender body, and very long antennæ; which darts its pointed tail into the bodies of the Aphides, at the same time depositing an egg in each. This egg produces a worm, which feeds upon the containing insect, till it has acquired its full growth; when it is usually changed to that kind of fly from whence it had its origin. In this, however, it is sometimes prevented by another sort of small black fly, which wounds this worm through its pearl-like habitation; and by laying one of its eggs therein, instead of the former fly, produces its own likeness.

I must however further observe, notwithstanding these insects have many enemies, they are not without friends ; if we may consider those as such, who are very officious in their attendance, for the good things they expect to reap thereby. The ant and the bee are both of this kind, collecting the honey in which the Aphides abound ; but with this difference, that the ants are constant visitors, the bee only when flowers are scarce. To which let me also add, that the ants will suck in the delicious nectar, while the Aphides are in the act of discharging it from the anus ; but the bees only collect it from the leaves, on which this honey-dew has fallen.

SECTION III.

In the autumn, I find three more generations of Aphides to be produced ; two of which make their appearance in the month of August, and the third usually before the middle of September. As the two first differ in no respect from those which we meet with in summer, it would be wasting time to dwell any longer upon them ; but the third, differing greatly from all the rest, demands our giving it a more serious attention. Though all the Aphides which have hitherto appeared were females, in this tenth generation are found several male insects ; not that they are by any means so numerous as the females, being only produced by a small part of the former generation. To which I must further add, that I have observed those which produce males, previously to have produced a number of females ; which in all respects resembling those already described,

scribed, I shall decline taking into any further consideration.

The females have at first altogether the same appearance with those of the former generations; but in a few days their colour changes from a green to a yellow, which is gradually converted into an orange-colour, before they come to their full growth. They differ likewise in another respect, at least from those which occur in the summer, that all those yellow females are without wings. The male insects are however still more remarkable; their outward appearance readily distinguishing them, from the females of this and all other generations. When first produced, they are not of a green colour like the rest, but of a reddish brown; and have afterwards, when they begin to thicken about the breast, a dark line along the middle of the back. These male insects come to their full growth in about three weeks time, and then cast off their last covering; the whole insect being after this operation of a bright yellow, the wings only excepted. But they soon change to a darker yellow, and in a few hours to a very dark brown; if we except the body, which is something lighter coloured, and has a reddish cast. They are all of the winged sort; and the wings, which are white at first, soon become transparent, and at length appear like very fine black gauze.

The males no sooner come to maturity, than they copulate with the females; in which act they are readily discovered, as they remain in conjunction for a considerable time, and are not easily disturbed. The commerce between them continues the whole month of October, and may be observed at all times of

of the day; though I have found it most frequent about noon, especially when the weather is moderately warm, with the sun overcast. The females, in a day or two after their intercourse with the males, I have observed to lay their eggs; which they usually do near the buds, when they are left to their own choice. Where there are a number crowded together, they of course interfere with each other; in which case, they will frequently deposit their eggs on other parts of the branches, or even on the spines with which they are beset. I do not however find that the eggs produced by these insects bear any proportion to the number of young ones which proceed from the females of other generations; not having observed any one insect to produce more than two or three, and that in appearance with great difficulty.

Having now traced their progress through the different seasons of the year, and observed the various metamorphoses which they successively undergo; I cannot help suspecting the insufficiency of human reason, in setting any scheme to which the different changes of insects may be accurately reduced. Though the indefatigable Swammerdam seems to have been fully convinced that there is no insect, whose changes may not be reduced to one or other of the four orders he has described; still the insect now under consideration, having at different seasons quite different appearances, cannot, I think, with strictness be confined to any of them. In the spring they seem in some measure to coincide with the first order, though in summer those with wings more properly belong to the second; but in
autumn,

autumn, the males may seem to come under one order, and the females under another; or, I should rather think these insects are not clearly reducible to any order.

SECTION IV.

Some of the insects now under consideration continuing to lay their eggs till the beginning of November, I choose to defer giving a more particular account of them, till the season for which they seem by nature to have been designed. These eggs are of a regular oval figure, being about the tenth part of an inch in length, and the twentieth in breadth; which, though it may seem a very inconsiderable bulk, is certainly large for so minute an insect. When they are first produced, their colour is green, but in a few days turns to brown, and by degrees becomes quite black. The covering of the eggs may be called thick, if compared with its small size; which at first is rather of a yielding nature; but, after being exposed to the air, soon contracts a greater firmness. If this covering is wounded, there issues forth a mucilaginous fluid, which is very transparent, and in appearance of a uniform consistence. These eggs adhere firmly to the branches on which they are deposited, by means of something glutinous wherewith they are besmeared, and in a most surprising manner resist all the severity of the winter.

Though I have just now observed, the contents of the eggs to have the appearance of an uniform fluid; that this cannot in reality be the case, sufficiently appears from the Aphides they produce in
the

the spring, without any other aid than the warmth of the season. Nor is a single insect to be esteemed the whole product of an egg, since it has been clearly shewn, that ten generations succeed each other; the first rudiments of which must have been originally in the egg, as the females have no communication with the males but in autumn. The wonder however becomes still greater, when we consider the number of individuals in each generation; this being, I am fully convinced, at a medium, not less than fifty. Whoever pleases to multiply by fifty, nine times over, may by this means form some notion of the great number of insects produced from a single egg; but will at the same time find that number so immense, as to exceed all comprehension, and indeed to be little short of infinity. How far this can be reconciled with any theory of generation which the ingenuity of man has hitherto invented, may be a contemplation not altogether unworthy our curiosity, though I fear it will not turn out much to the credit of our reasoning faculties.

The ancient doctrine of equivocal generation, as also that from an admixtion of the feminal matter of both sexes, being now quite rejected by all modern naturalists; two other opinions seem to have sprung up in their stead. While one party asserts, that the original organization of the foetus exists in the ovary of the female, and that it is vivified by a subtle spirit in the spermatic fluid of the male; the other lays it down for a certainty, that the eggs of the female are only to be considered as a proper nidus, provided for the reception of those minute animalcules, with which the male semen is found to

abound. As the former opinion does not appear to have any certain fact to support it, we may well suspect an insufficiency in the cause to produce the effect assigned; but, supposing it adequate to the production of one generation, who can conceive a subtle spirit to remain in force for ten generations, and that through all the various seasons of the year? With regard to the latter, I must observe, that the animalcules of Leeuwenhock being compared with Malpighi's first rudiments of the chicks, their resemblance is not so striking as to afford me the least conviction: but should we allow these animalcules requisite to produce the first generation, how then are the subsequent nine generations produced without them? Not being able to answer these queries myself, nor expecting them to be readily answered by others; it seems most prudent to observe with diligence what nature does, without being over anxious to discover by what means. Let us rest satisfied in admiring the wonderful effects of generation, while we refer the primary efficient cause to the eternal will and power of an Almighty Creator.

Read March 21, 1771.

XXIII. *Meteorological Observations at Ludgvan in Mount's-Bay, Cornwall, 1770:*
By William Borlase, D. D. F. R. S. Communicated by Dr. Jeremiah Milles, Dean
of Exeter, and F. R. S.

Month.	Barometer.	State of the Weather and Wind.	Fahrenheit's Thermom.	Ombr.
January	Highest 28 30, 51 } Very high Lowest 7 29, 36	Snow from the 5th to the 9th; 10th, snow all gone. Violent storm on the 11th; nine days calm; rest mifty, with fogs, showers, and wind, East and West winds nearly equal, latter rather more; hard frost on the 7th day only.	Med. Highest 2 51 } Lowest 7 32 } 43 $\frac{1}{3}$	Inches. 3 160 3 3000
February	Highest 14 30, 39 Lowest 18 29, 1	Calm 12 days; a violent storm all night the 18th; a slight frost only on the 24th; wind Westerly 21 days.	Highest 14 51 } Lowest 24 36 } 44 $\frac{1}{3}$	3,300
March	Highest 2 30, 6 Lowest 10 28, 71	Sleet, deep snow and lying, the 16th, 17th, 18th, 19th, 20th, with hard frost; frost, and hard snowing and windy, 23d, 24th; snow, hail, and frost, 26th, 27th, 28th, 29th. Frost and snow gone the 30th, with hazy mists. Wind mostly from the North and East, being to the West as 19 to 12.	Highest 31 51 $\frac{1}{2}$ } Lowest 21 32 } 41 $\frac{5}{3}$	4,040
April	Highest 29 30, 31 Lowest 6 28, 90	Mixture of all weathers, but that of frost and snow we had none. Wind 22 days from the North; rest nearly equal.	Highest 30 54 } Lowest 9 39 } 46	3,400

May

Month.	Barometer.	State of the Weather and Wind.	Fahrenheit's Thermom.	Omb.
May	Highest 1 29.98 Lowest 5 28.99	First 7 days windy and stormy showers; in the rest 20 days of calm, mostly fair. Wind 16 days from the East equally mixed with North and South.	Med. Highest 28 60 } Lowest 3 40.5 }	Inches. 3.000
June	Highest 14 30.7 Lowest 19 29.17	Mostly hazy and misty. Fair, windy, rain and cloudy, nearly equal. Wind 26 days from the West, chiefly mixed with the South.	Highest 9 61 } Lowest 20 49 }	3.200
July	Highest 12 30.20 Lowest 18 29.32	Calm 24 days, some hazy and misty, but little or no rain. Wind Westerly 22 days, its mixture mostly with the South.	Highest 13 66 } Lowest 4 52 }	1.950
August	Highest 4 30.10 Lowest 20 29.62	18 calm days; rest misty, hazy, or fair. On the 6th at 8 P. M. much lightning; violent about a quarter past 9, with very rapid flashes, and loud thunder, till two A. M. when it began to rain with a violent flood for a quarter of an hour; afterwards, much rain, but no more thunder or lightning. Wednesday the 8th, close calm morning; about five A. M. thunder, with much lightning; about six rained violently, at nine cleared off, and a fair day. Thursday morning the 9th, 2 A. M. lightning and thunder, but not so violent; wind Easterly; wind East and West nearly equal, with North and South nearly equal.	Highest 6 71 } Lowest 31 55 }	1.850
September	Highest 28 30.10 Lowest 26 28.84	Weather mostly variable, and of all kinds. On the 18th hazy and calm, A. M.; P. M. a storm and hard rain; on the 25th and 26th a continued storm to the 27th; the 28th calm with mists; wind twenty-five days South, with a greater mixture of the West.	Highest 6 63 } Lowest 22 53 }	2.840

Month.	Barometer.	State of the Weather and Wind.	Fahrenheit's Thermom.	Ombr.
October	Higheft 7 30.24 Lowest 22 28.69	First eleven days calm and mild; next twelve days violent rains and windy; next eight days showery, and rains. Wind twenty-five days Westerly, with eighteen days mixture of the North; rest equal.	Med. Higheft 1 60 } Lowest 22 43 } 20 50 31	6,550 at least, the receiver being broken -fall when looked to: whether overflowed uncertain.
November	Higheft 4 29.94 Lowest 8 28.44 Very low here.	Rain twenty-two days; rest stormy, windy, and cloudy. Wind Westerly twenty-six days; mixed mostly with the South. An extraordinary fall of rain this month; on the 25th a storm all night.	Higheft 3 53 } Lowest 20 37 } 47 1 47 1	7,250
December	Higheft 1 30.0 Lowest 23 29.20	26 days rain and showers; much stormy weather. On the 18th in the evening, began a violent storm from West, and W. S. W.; the extreme was at eleven P. M. Wind twenty-six days blew from the West; mostly mixed with the South.	Higheft 15 52 } Lowest 25 37 } 45 1 45 1	4,100

Total Rain this Year 1770, at least 44,136⁶⁴⁰

XXIV. *Description of a new Hygrometer:*
By Mr. John Smeaton, F. R. S.

Read March 21,
 1771.

HAVING some years ago attempted to make an accurate and sensible hygrometer, by means of a hempen cord, of a very considerable length; I quickly found, that, though it was more than sufficiently susceptible of every change in the humidity of the atmosphere, yet the cord was, upon the whole, in a continual state of lengthening. Though this change was the greatest at first, yet it did not appear probable that any given time would bring it to a certainty; and futhermore it seemed, that, as the cord grew more determinate in mean length, the alteration by certain differences of moisture grew less. Now as, on considering wood, paper, catgut, &c. there did not appear to be a likelihood of finding any substance sufficiently sensible of differences of moisture, that would be unalterable under the same degrees thereof; this led me to consider of a construction which would readily admit of an adjustment; so that, though the cord whereby the instrument is actuated may be variable in itself, both as to absolute length, and difference of length under given degrees of moisture, yet that, on supposition of a material departure from its original scale, it might be readily restored

fired thereto, and in consequence that any numbers of hygrometers, similarly constructed, might, like thermometers, be capable of speaking the same language.

The two points of heat, the more readily determinable in a thermometer, are the points of freezing and boiling water. In like manner, to construct hygrometers which shall be capable of agreement, it is necessary to establish two different degrees of a moisture which shall be as fixed in themselves, and to which we can as readily and as often have recourse as possible. One point is given by making the substance perfectly wet, which seems sufficiently determinable; the other is that of perfect dry; but which I do not apprehend to be attainable with the same precision. A readiness to imbibe wet, so that the substance may be soon and fully saturated, and also a facility of parting with its moisture, on being exposed to the fire to dry; at the same time that neither immersion in water, nor a moderate exposition to the warmth of the fire, shall injure its texture; are properties requisite to the first mover of such an hygrometer, that in a manner exclude all substances that I am acquainted with, besides hempen and flaxen threads or cords, and what are compounded thereof.

Upon these ideas, in the year 1758 I constructed two hygrometers, as near alike as possible, in order that I might have the means of examining their agreement or disagreement on similar or dissimilar treatment. The interval or scale between dry and wet, I divided into 100 equal parts, which I call the degrees of this hygrometer. The point of 0 denotes

denotes perfect dry ; and the numbers increase with the degrees of moisture to 100, which denotes perfect wet.

On comparing them for some time, when hung up near together in a passage or stair-case, where they would be very little affected by fire, and where they would be exposed to as free an air as possible in the inside of the house, I found that they generally were within one degree, and very rarely differed two degrees ; but, as these comparisons necessarily took up some time, and were frequently interrupted by long avocations from home, it was some years before I could form a tolerable judgement upon them. One thing I soon observed, not altogether to my liking ; which was, that the flaxen cords, which I made use of, seemed to make so much resistance to the entry of small degrees of moisture (such as is commonly experienced within doors in the situation above-mentioned) that all the changes were comprized within the first 30 degrees of the scale ; but yet, on exposing them to the warm steam of a wash-house, the index quickly mounted to 100. I was therefore desirous of impregnating the cords with something of a saline nature, which should dispose them more forcibly to attract moisture ; in order, that the index might, with the ordinary changes of moisture in the atmosphere, travel over a greater part of the scale of 100 : how to do this in a regular and fixed quantity, was the subject of many experiments, and several years interrupted enquiry. At last, I tried the one here- after described, which seemed to answer my intentions in a great measure ; and though, upon the whole, it does not appear

Fig. 2.



Fig. 3.

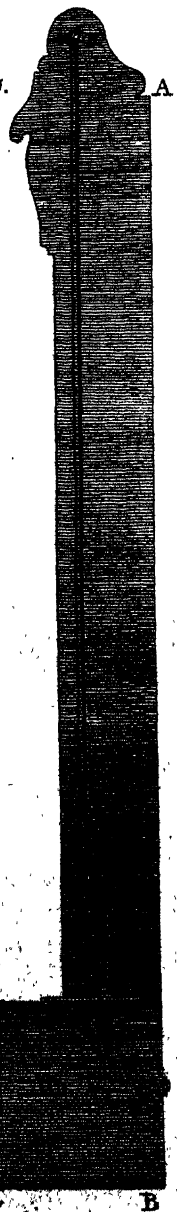
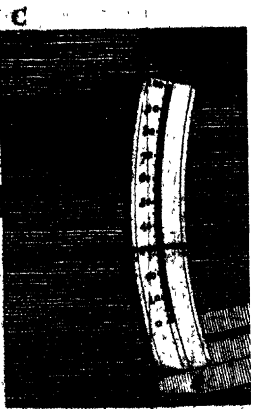


Fig. 4.



1/4 of nat. size.

Fig. 3.

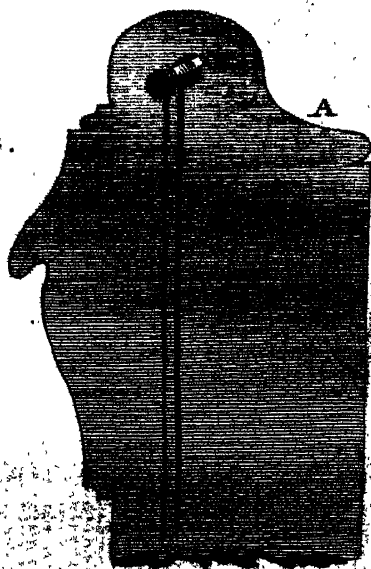
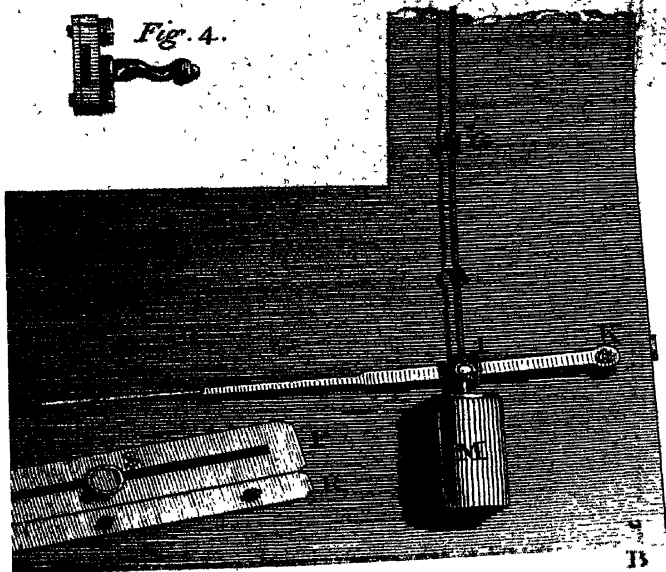


Fig. 4.



1/3 of real size

Author etc.

pear likely that this instrument will ever be made capable of so accurate an agreement, as mercurial thermometers are made to be; yet, if we can reduce all the disagreements of an hygrometer within $\frac{1}{4}$ th part of the whole scale, it will probably be of use in some philosophical enquiries, in lieu of instruments which have not as yet been reduced to any common scale at all.

Description of the Hygrometer.

Fig. 1 and 2, A B C is an orthographick delineation of the whole instrument seen in front in its true proportion.

D E is that of the profile, or the instrument seen edgeways.

F G, in both, represents a flaxen cord, about 35 inches long, suspended by a turning peg F, and attached to a loop of brass wire at A, which goes down into the box cover H, which defends the index, &c. from injury, and by a glass exposes the scale to view.

Fig. 3. shews the instrument to a larger scale, the upright part being shortened, and the box cover removed; in which the same letters represent the same parts as in the preceeding figures; G I are two loops or long links of brass wire, which lay hold of the index K L, moveable upon a small studd or center K. The cord F G is kept moderately strained by a weight M, of about half a pound avoirdupoise.

It is obvious, that as the cord lengthens and shortens, the extreme end of the index rises and falls, and successively passes over

N 2 the scale, disposed in the arch of a circle, and containing 100 equal divisions. This scale is attached to the brass sliding ruler Q P, which moves upon the directing piece R R, fixed by screws to the board, which makes the frame or base of the whole; and the scale and ruler, N Q P, is retained in any place, nearer to or further from the center K, as may be required, by the screw S.

Fig. 4. represents in profile, the sliding piece, and studd I. (fig. 3.), which traverses upon that part of the index next the center K; and which can, by the two screws of the studd, be retained upon any part of the index that is made parallel; and which is done for 3 or 4 inches from the center, for that purpose. The studd is filed to the edges, like the fulcrum of a scale beam, one being formed on the underside, the other upon the upper, and as near as may be to one another. An hook formed at the lower end of the wire loops C I, retains the index by the lowermost edge of the studd, while the weight M hangs by a small hook upon the upper edge: by these means the index is kept steady, and the cords strained by the weight, with very little friction or burthen upon the central studd K.

Fig. 5. is a parallelogram of plate brass, to keep out dust, which is attached to the upper edge of the box cover H, and serves to shut the part of the box cover necessarily cut away, to give leave for the wire G I to traverse with the sliding studd (fig. 4.) nearer to, or further from, the center of the index K; and where in (fig. 5.) a is an hole about $\frac{1}{4}$ of an inch diameter, for the wire G I to pass through, in the rising and falling of the index, freely.

freely without touching; *b* is a slit of a lesser size, sufficient to pass the wire, and admit the cover to come off without deranging the cord or index; *c c* are two small screws applied to two slits, by which the plate slides lengthways, in order to adapt the hole *a* to the wire G I, at any place of the studd I upon the index K L.

Remarks on the preceding Construction.

1st. In this construction the index K L, being 12 inches long, 4 inches from the extreme end are filed so narrow in the direction in which it is seen by the eye, that any part of these 4 inches, lying over the divisions of the scale, becomes an index thereto. The scale itself slides 4 inches, so as to be brought under any part of the 4 inches of the index, attenuated as before mentioned.

2dly. The position of the directing piece R R is so determined, as to be parallel to a right line drawn through the point *o* upon the scale, and the center K of the index; consequently, as the attenuated part of the index forms a part of a radius, or right line from the same center, it follows, that whenever the index points to *o* upon the scale, though the scale is moved nearer to or further from the center of the index, yet it produces no change in the place to which the index points.

3dly. When the divided arch of the scale is at 10 inches from the center (that is, at its mean distance) then the center of the arch and the center of the index are coincident. At other distances, the extremes of which are 8 or 12 inches, the center of

the divisions and center of the index, pointing thereto, not being coincident, the index cannot move over spaces *geometrically* proportionable to one another in all situations of the scale; yet, the whole scale not exceeding 30 degrees of a circle, it will be found on computation, that the error can never be so great as $\frac{1}{1000}$ th part of the scale, or 1 degree of the hygrometer; which in this instrument being considered as an indivisible, the mechanical error will not be sensible.

Choice and Preparation of the Cord.

The cord here made use of is of flax, and betwixt $\frac{1}{10}$ th and $\frac{1}{8}$ th of an inch in diameter; which can readily be ascertained by measuring a number of turns made round a pencil or small stick. It is a sort of cord used in London for making nets, and is of that particular kind called by net makers *flaxen three threads laid*. I do not imagine that the fabrick of the cord is of the most material consequence; but yet I suppose, when cords can be had of similar fabrick, and nearly of the same size, that some small sources of variations will be avoided. In general I look upon it that cords, the more they are twisted, the more they vary by different degrees of moisture, and the less we are certain of their absolute length; therefore those moderately twisted, I suppose, are likely to answer best.

A competent quantity of this cord was boiled in one pound avoirdupoise of water, in which was put two pennyweights troy of common salt; the whole was reduced by boiling to 6 $\frac{1}{2}$ avoirdupoise, which

was done in about half an hour. As this ascertains a given strength of brine on taking out the cord; it may be supposed that every fibre of the cord is equally impregnated with salt. The cord being dried, it will be proper to stretch it; which may be done so as to prevent it from untwisting, by tying three or four yards to two nails, against a wall, in an horizontal position, and hanging a weight of a pound or two to the middle, so as to make it form an obtuse angle. This done for a week or more in a room, will lay the fibres of the cord close together, and prevent its stretching so fast after being applied to the instrument, as it otherwise would be apt to do.

I have mentioned the sizes and principal dimensions that I have used; as the instruments may as well be similarly constructed as otherways; but I do not apprehend it to be very material to agree in any thing but the strength of the brine on taking the cord out of it. If the cord is adapted to the instrument some days before its first adjustment, I apprehend it will be the more settled.

Adjustment of the Hygrometer.

The box cover being taken off, to prevent its being spoiled by fire, and chusing a day naturally dry, set the instrument nearly upright, about a yard from a moderate fire; so that the cord may become dry, and the instrument warm, but not so near as would spoil the finest linen by too much heat, and yet fully evaporate the moisture; there let the instrument stay, till the index is got as low as it will go,
now

now and then stroking the cord betwixt the thumb and finger downwards, in order to lay the fibres thereof close together, and thereby causing it to lengthen as much as possible: when the index is thus become stationary, which will generally happen in about an hour (more or less as the air is naturally more or less dry), by means of the peg at top raise or depress the index, till it lays over the point *a*; this done, remove the instrument from the fire, and having ready some warm water in a teacup, take a middling camel's hair pencil; and dipping it in the water, gently anoint the cord, till it will drink up no more, and till the index becomes stationary, and water will no more have effect upon it; which will also generally happen in about an hour. If in this state the index lays over the degree marked 100, all is right: if not, slack the screw *S*, and slide the scale nearer to or further from the center, till the point 100 comes under the index, and then the instrument is adjusted for use: but, if the compass of the slide is not sufficient to effect this, as may probably happen on the first adjustment, slack the proper screws, and move the sliding studd *I* nearer to or further from the center of the index, according as the angle formed by the index, between the points of dry and wet, happeneth to be too small or too large for the scale; the quantity may easily be judged of, so as the next time to come within the compass of the slide of the scale; the quantity of slide being $\frac{1}{4}$ of the length of the index, and consequently its compass of adjustment $\frac{1}{4}$ of the whole variable quantity. Now as sliding the studd *I* will vary the position of the index

dex respecting the point of σ , this movement is only to be considered as a rough or preparatory adjustment, to bring it within the compass of the slide of the scale; which will not often happen to be necessary after the first time; but in this case, the adjustment must be repeated in the same manner, by drying and wetting as before described.

It is to be remarked, that, as the cord is supposed impregnated in a given degree with common salt, and this not liable to evaporate, care must be taken in wetting, that no drops of wet be suffered to fall from the cord: for, by the observance hereof, the original quantity is preserved in the cord.

Observations made upon two original Hygrometers.

These hygrometers were first adjusted, after the impregnation of the cords with common salt, in February 1770; they were kept together in a staircase till the summer following; they were frequently observed, and rarely found to differ more than one degree.

In summer, one of them remaining in the former place, the other was removed into a passage through a building; which having no doors, and the instrument being hung so that neither rain nor the direct rays of the sun could fall upon it, thereby it became exposed to the winds, and the free passage of the open air. In these situations the two hygrometers not only differed very greatly in quantity, but even frequently were moving different ways. They were thus continued till January 1771, in which space of time I observed, that the most ordinary place of the
index.

index was between 15° and 25° in the open air ; that at 40° the atmosphere felt very sensibly moist ; but yet it was frequently above 60° ; and more than once at 70° , or very near. I have therefore marked the point of 0° *dry* ; 20° the *mean*, 40° *moist*, 70° *very moist*, 100° *wet*. I do not, however, mean those words (that of dry and wet excepted) as of any other intent, than that of general direction, in like manner as those upon the barometer ; leaving the relative degrees of moisture to be judged of by the scale.

In the month of January last, I restored the exposed hygrometer to its former place in the staircase, when both instruments were again compared together ; and they rarely differed more than 1 degree, and never so much as 2° . After this, they were both removed together to the out passage ; and there they agreed nearly in the same manner, the utmost difference not exceeding 2 degrees. After some trial here, one of them was readjusted, leaving the other hanging in its place. On restoring the new adjusted instrument to the other, they now differed about 5° , the new adjusted one standing so much higher. The day following the other was readjusted also, and afterwards restored to its place with the former, which had been left in the out passage ; and after this readjustment they both agreed to 1° . This being observed for some days, one of them was taken down, in order to be packed up for London ; this I have now the honour of exhibiting to the Royal Society ; and I beg to leave it in the Society's house, that in case any one should be desirous

desirous of having an instrument made on the same plan, they may have recourse thereto.

It appears from the foregoing observations, that, in the compass of 11 months, the cords had stretched the value of 5° : and I also observed that they both had contracted their compass about 10° . I would, therefore recommend, that an hygrometer should from its first adjustment, be readjusted at the end of three months, and again, at the end of six months from the first; after that, at the interval of about six months, to the end of two years from the beginning; and after that, I apprehend that once a year will suffice; the best time of adjustment, being in the dry and warm weather of July or August: and by these means, I apprehend the instrument will be always kept within 2° of its proper point.

Respecting the sensibility of this instrument, it has that in a greater degree than its constancy to its scale can be depended upon, which was all that I intended; where greater degrees of sensibility are required, to make comparisons at small intervals of time, the beard of a wild oat, and other constructions may be used, with advantage; this instrument being considered as a cheque upon them as to more distant periods.

General Conclusion.

I am aware that an hygrometer actuated by any principle of the kind here made use of may not be a measurer of the quantity of moisture, actually dissolved in, and intimately mixed, with the air; but only indicates the disposition of the air to part with,

or precipitate the water contained in its substance; or, on the contrary, to dissolve and imbibe a greater quantity: but as it is by separating the effects of natural causes, that we are enabled to judge of these causes, and from thence their effects when again compounded; every attempt to ascertain the operations of a simple cause will have its value in the search into nature: nor can we *a priori* determine the value of any new instrument; for, if it should lead to a single discovery, or even to ascertain a single fact, this may again lead to others of great importance, of which we might have, either none, or an imperfect idea of before. For my own part, I have always looked on a thick fog, and the sweating, or condensation of the water's vapours upon the walls in the inside of buildings, to be the greatest marks of a moist atmosphere: whereas I have not always found the hygrometer affected at these times in the highest degree. On the contrary at the close of a fine day, and the fall of the dew on the sudden approach of a frost, I have found the hygrometer more affected by moisture than in some of the preceeding cases; and still more by a falling dew in the time of an hard frost. I just mention these matters of hints for the enquiry of others; not having had length of time, since I brought the instrument to answer my intention, to make any absolute conclusions.

I am sorry I have been obliged to take so much compass, to describe and explain a very simple instrument; but as I meant at the same time to give some idea of what is to be expected from it, I thought
it

it more excusable to be prolix than not sufficiently explicit.

London,
March 21, 1771.

J. Smeaton.

P. S. It is to be noted, that, after each readjustment, though the hygrometers would generally within a few hours come near their point, yet it was not till the next day that they could be depended on, as having come to their nearest agreement.

XXV. *Letter from Mr. John Baptist Beccaria, of Turin, F. R. S. to Mr. John Canton, F. R. S. on his new Phosphorus receiving several Colours, and only emitting the same.*

Clarissimo Viro

JOANNI CANTON, M. A. et Lond. Soc. Membro
meritiff.

Joannes Baptista Beccaria, ex Scholiis Piis, S. P. D.

Read April 11, 1771. **T**HECAS plures confici curavi ex lamina ferrea cylindræas intus nigerrimas. Operculum late pertusum cryſtallo occluditur, colore in theca quaque diverſo. Singulis thecis offas immiſi ex phosphoro calcareo-ſulphureo ſingulas omnia pares. Hæ clauſæ ſoli objiciuntur ſimul omnes; aſportatas in tenebras aperio, atque offam, quæ per cryſtallum viridem, video vireſcere; rubeſcere, quæ per rubram; flaveſcere, quæ per flavam cryſtallum lucem imbuir: videlicet conſit hoc experimento jam non quantam ſolum lucem ebiberit phosphorus, ſed et qualem, eam ipſum unice emittere. Quod etiam experimentum Regiæ Societati obveniet fortaiſſe non injucundum. Vale.

Summo Franklinio obſequium meo nomine, et ſalutem plurimam dicas rogo.

XXVI. *Some*

XXVI. *Some Remarks on the Effects of the late Cold in February last: in a Letter from the Rev. R. Watſon, Fellow of Trinity College, and Profeſſor of Chemiſtry at Cambridge, to Mathew Maty, M.D. Sec. R. S.*

Dear Sir,

Trin. Coll. Cam. March 27, 1771.

Read April 11, 1771. **O**N the 12th of laſt February, about an hour after ſun riſing, I obſerved at Cambridge a degree of cold which is very unuſual in England, though common enough in more northern climates. Fahrenheit's thermometer, made by Dollond, as well in the open air, as when covered with ſnow, ſtood as low as 6° above 0. The Cam, by no means a rapid river, remained unfrozen; at the ſides indeed there was a little ice, and ſome ſmall flakes floating in the middle. This is no very uncommon phænomenon. The Seine was not frozen at Paris in 1709, though the cold continued for two days one degree greater than in the preſent caſe. Various reaſons have been produced, in order to account for this ſeeming deviation from the uſual courſe of nature. It hath been generally believed that

that the strong current in the Seine impeded the congelation: motion will certainly hinder the parts of fluid bodies from acquiring a regular arrangement; but it may be doubted whether it will wholly prevent their coalescence, in any case where the degree of heat is less than what would keep them fluid if they were quiescent. We have frequent instances in chemistry, of saturated solutions of salts remaining perfectly fluid whilst at rest, and of forming thick coagulums upon the least motion. Melted metals, glass, resins, &c. appear to continue fluid for a longer time, after being taken from the fire, by having their parts moved, than if they are left at rest; because the superficies which is exposed to the air is constantly changing, and the whole mass becomes uniformly cold and fixed at once, as soon as it has parted with the heat necessary for its fusion. The most rapid rivers would probably experience a similar change, did the cold in the atmosphere continue long enough to be communicated to the whole body of the water: for upon taking the thermometer out of the snow, which laid upon the bank of the river, and immersing it into the water, it suddenly rose 26° , and stood at 32° , or higher; so that the air was very considerably colder than the water: nor is this at all to be wondered at, when we consider that great degrees of cold may be suddenly produced in the atmosphere by causes which do not immediately operate upon other bodies. Thus the influx of colder air from the northern latitudes, or the descent of that which always remains exceedingly cold in the upper parts of the atmosphere in the
same

same latitude, may in a few hours wholly change the air of a particular district: or, if from any peculiar circumstance the air should become unusually dry, and consequently disposed to dissolve much water, a great degree of cold might be almost instantaneously produced; but which could not be communicated to other bodies, in a little time, by so rare a fluid as the air.

During the forementioned degree of cold, a thick vapour was seen rising from the surface, and marking as it were the course of the river. If we attribute the elevation of this vapour to the attraction of the air, rather than to the comparative warmth of the water (for water just beginning to freeze is observed not to lose of its weight by evaporation *in vacuo*) the great cold may be thought perhaps to have proceeded from the solution of water in air which was then carrying on; for the earth was glutted with humidity, and the air was become dry, having been freed from its water by an almost incessant precipitation for three days, under the form of snow or sleet. It is very remarkable, that the extreme cold of January 13, 1709, came on at Paris, with a gentle south wind, and was diminished when the wind changed to the north; this is accounted for by M. de la Hire, from the wind's having passed over the mountains of Auvergne to the south of Paris, then covered with snow; and by Mr. Homberg, from the reflux of that air, which had been flowing for some time from the north. I do not see from what philosophical principle it can be supposed, that the same air in its regress from a southern latitude should

be.

be colder than in its progress from a northern; and as to the other opinion, the phænomenon of the cold's increasing upon the wind's changing from north to south, hath been taken notice of in other places, where there was no snow to refer it to. May it not deserve to be considered, whether the sudden solution of large quantities of aqueous vapours, brought from the south into a dry northern air, be not a cause adequate to the effect produced? The solubility of water in air is distinctly mentioned by Dr. Halley, in the *Philos. Trans.* N° 192; and in the 6th Vol. of the French *Encyclopedie*, published in 1756; and more fully and ingeniously treated of by Dr. Hamilton in 1765: the cold attending the solution is a phænomenon similar to that attending many other chemical solutions, and is in a less degree sensibly felt by every one who goes into a room newly washed, or street in the summer time lately watered.

Upon taking the thermometer out of the river, its bulb was quickly covered with a thin crust of ice, which defended it so much from the cold subsisting in the atmosphere, that it did not sink two degrees in ten minutes; whereas, when it was wiped dry after immersion in water, it sunk above 20° in a less space of time: this circumstance shews that ice doth not transmit cold, and is explained by the experiments of M. Richmann, who hath established it as a principle, that metallic substances are far more quickly affected in their dimensions by the transitions from heat to cold, and the contrary, than any other bodies yet known.

Being desirous of observing the effect of this extraordinary degree of cold upon various saline solutions, I hastened to my laboratory; where I happened to have a great many solutions of salts corked up in quart bottles; the bottles were not all full, but the solutions were perfectly saturated; the state in which I found them is expressed in the following table.

Frozen wholly	Frozen nearly	Wholly fluid
Alum	Green vitriol	Sea salt
Cream of Tartar	Blue vitriol	Sal gemmæ
Arfenic	Rochelle salt	Sal ammoniac
Corros. sublimate	Glauber's salt genuine	Volatile alkaline salt
Borax	White vitriol, a few	Fixt alkali per deliq.
Nitre	glacial spicula	Epſom ſalts } Lyming- Glauber ſalts } ton.

These experiments agree upon the whole very well with those of professor Braunius, related in the Petersburg Commentaries for 1763: for, though his saturated solutions of Epſom salts, and of fixt alkali, had begun to freeze in a less degree of cold, yet it is probable that his Epſom salts might have been different from those manufactured at Lymington, and the solution of his fixt alkali not so well saturated as that which is made per deliquium.

During the same frost, I endeavoured to find out the powers, by which different salts, when they are dissolved in water, resist congelation. With this view I dissolved equal weights of salts, equally dry, in equal quantities of water, and exposed the solu-

tions, when they were arrived at the same degree of heat, in vessels of equal and similar figures to the same freezing atmosphere; and accurately marking the times in which they began to freeze, I found them observing the following order: first alum, then Rochelle salt, green vitriol, sugar refined, white vitriol, vitriolated tartar, Glauber's salt, mineral fixt alkali, nitre, blue vitriol, volatile alkali, sal ammoniac; last of all, sea salt. These experiments were repeated once or twice with some attention; yet I would not be thought to propose the order in which I have arranged the several salts, as wholly to be relied on. It were to be wished, that a sufficient number of experiments were accurately made upon this subject; some general truths relative to metallic earths, and alkaline neutral salts, would probably be obtained therefrom, which, however unimportant in themselves, might serve, upon some occasion or other, as connecting links, to extend the chain of our ideas. By this comparison of equal quantities of different salts dissolved in equal quantities of water, we might be enabled to speak with as much precision, concerning the powers by which they resist congelation, as we do concerning those by which they resist putrefaction. I know not whether it may not be thought too curious a remark to observe, that the Ocean is impregnated with that species of salt which resists congelation with the greatest power, and in such a quantity as tends not to preserve entire, but to accelerate the dissolution of the numberless animals which are daily dying in it. Beccher, it hath been asserted, was acquainted with this property of common salt; but

but he seems only to speak of it as a far less efficacious anti-septic than sugar; at least, the honour of ascertaining the proportion in which it acts as a septic undoubtedly belongs to Sir John Pringle; for Beccher, in his *Physica Subterranea*, lib. I. sect. v. cap. 1. where he is speaking of this matter, says, "quod nimius salis usus corpus putrescere faciat, sicut modicus a putredine præservat."

To a table exhibiting the relative powers of neutral salts in resisting congelation, another might be usefully added, denoting the powers of all the known acids and alkalies when diluted to a given density; as also of vinous spirits, from highly rectified spirits of wine to water impregnated with the minutest quantity of spirit. Not but that it may be conjectured *a priori*, that in this last case the resistance to congelation would be directly as the quantity of spirit contained in given quantities of water. I made an experiment of this kind with sea salt; in equal quantities of water were dissolved quantities of sea salt, increasing in the arithmetical progression, 0, 5, 10, 15, 20, &c.; the times in which the solutions began to freeze, reckoning from the time in which simple water began, increased accurately in the same progression: hence it may be inferred, that, in salt of the same kind, the resistance to congelation is in the direct simple proportion of the quantity of salt dissolved; this conclusion cannot be extended to salts of different kinds, since water saturated with sea salt is more difficultly congealed than when saturated with various other salts, which it dissolves in greater quantities.

These observations, which are only proposed as hints to those who have more leisure for experimental enquiries, you will be so obliging as to communicate to the Royal Society, or not, as you think proper. I am,

Dear Sir,

Your most faithful

and obedient servant,

R. Watson.

XXVII. *A Letter from Thomas Barker, Esq; of Lyndon in Rutlandshire, to James West, Esq; Pres. R. S. concerning Observations of the Quantities of Rain fallen at that Place for several Years.*

S I R,

Lyndon, March 22, 1771.

Read April 18;
1771.

ON the other side is the quantity of rain, which has fallen at Lyndon in Rutland, since May 1736, with a table of the mean rain in the first four or five years, and every ten years since; which shews that there has been more rain in the latter part of this period, than in the former. But the least four years were from 1740 to 43, little more than $16\frac{1}{2}$ inches a year; and the greatest four years from 1767 to 70, above $25\frac{1}{2}$ inches a year. For comparing of dry seasons and wet ones, I have made a table of the three driest months, the three driest two months, three, four, &c. to twelve successive months; and a like table of wet ones: but as the years 1763, 68, 70, exceeded any others, I have made another like table of them. There are no three months come up to the last quarter of 1770,

7 $\frac{1}{2}$

7½ inches of which came in three weeks, from Nov. 6 to 26; but 1763 and 68, were wetter than 70, except those three months: and in this country 63 was the wettest; yet, by what I heard, I suppose 68 exceeded it in many places. In common speaking, those are called wet years, in which the summer, the growing season, was wet and cold; and those dry ones, wherein the summer was dry and burning; so that though 1740, 1, 2, and 3, had all but little rain, yet 42 and 43 were not properly called dry years, because the ground never burned long together; and as the different degrees of heat, and frequency of rain, do not appear in this table, one cannot certainly judge, from the quantity of rain, which were the driest summers. Those complained of for dry, were, 1737, 40, 41, 50, 60, 62, and 65; but the hottest and most burning were 1750, 60, and 62; and 40 and 65 were cold and dry. On the other hand, the wet years were 1738, 39, 51, 52, 56, 63, and 66 to 70; but the wettest 1751, 56, 63, and 68; and above all the last quarter of 1770.

Feb. 12 last, the thermometer abroad, was down at 4 of Fahrenheit's scale, which is lower than I have observed it in above 20 years past; the lowest I had before observed, was 10½, Jan. 5, 1768. I have therefore given the rise and fall of the thermometer for above a week in the frost.

	Morn	Afternoon
Feb. 8	27 N.byW.	36 E.N.E.
9	26½ N.E.	29½ N.E.
10	28 N.E.	33 E.byW.
11	24½ E.S.E.	29½ S.W.
12	4 W.byN.	31 N.W.
13	15½ W.	30½ S.
14	9 S.W.	25 S.S.W.
15	12 S.W.	27½ E.
16	31 E.byW.	35½ E.

It was remarkable, that as long as the wind continued N. E. the frost was moderate, when it turned S. W. it became very severe; and when the wind turned back into the East again, the frost went away. This looks as if the weather was severer Southward than here; as I think was likewise the case in Feb. 1754, which was also a very cold season.

I am, Sir,

Your humble servant;

Tho. Barker.

Lyndon, mean rain at different periods

	4 years 5 years 36-40	10 years 40-50	10 years 50-60	10 years 60-70	34 years 35 years 36-70
Jan.	1.271	1.410	1.722	1.606	1.544
Feb.	1.194	0.856	1.146	1.715	1.234
Mar.	1.101	1.374	1.472	1.143	1.303
April	1.341	1.394	1.905	1.298	1.510
May	1.408	1.196	1.609	1.661	1.476
June	1.406	2.272	2.158	2.614	2.213
July	2.623	2.052	2.974	2.478	2.518
Aug.	3.074	1.105	2.701	2.302	2.194
Sept.	2.128	1.765	1.370	1.731	1.694
Oct.	1.517	1.741	1.561	2.673	1.924
Nov.	0.985	1.939	1.614	2.325	1.820
Dec.	1.742	1.443	1.898	1.729	1.698
	19.790	18.547	22.130	23.275	21.118

Annual quantities of rain.

1736	1737	1738	1739	1740	
	0.615	1.788	2.430	0.250	Jan.
	1.660	0.568	2.487	0.060	Feb.
	1.768	1.189	0.814	0.632	Mar.
	0.676	1.230	2.585	0.872	April
0.985	1.000	2.160	1.860	1.036	May
0.922	0.720	2.420	1.537	1.430	June
6.550	0.306	0.624	1.905	3.668	July
2.300	6.300	1.418	2.350	2.800	Aug.
1.540	3.465	2.110	1.903	1.620	Sept.
2.350	2.025	1.640	0.522	1.050	Oct.
0.620	9.570	0.692	1.557	1.488	Nov.
1.500	1.830	1.320	1.540	2.412	D c.
16.967	70.435	17.159	21.660	17.318	

Annual quantities of rain at Lyndon.

	1741	1742	1743	1744	1745	1746	1747	1748	1749	1750	
Jan.	1.088	1.435	0.406	1.198	0.827	1.758	2.862	0.938	2.483	1.107	Jan.
Feb.	0.618	0.863	0.365	0.941	0.572	1.706	1.211	0.369	1.017	0.894	Feb.
Mar.	0.568	0.055	1.193	1.428	2.541	1.880	1.240	1.946	1.870	1.020	Mar.
April	0.270	1.908	1.252	2.759	1.708	0.762	1.017	1.367	0.548	2.248	April
May	0.441	1.546	0.868	1.257	1.137	0.546	2.819	1.178	1.107	0.995	May
June	1.366	1.430	0.379	3.479	3.451	2.900	1.562	3.044	3.039	2.069	June
July	0.873	3.136	5.230	0.820	0.724	1.442	2.248	3.484	1.049	1.510	July
Aug.	1.633	0.160	1.124	0.957	3.934	0.456	0.071	1.305	0.767	0.640	Aug.
Sept.	4.935	1.778	0.008	3.298	0.899	1.633	1.922	0.553	0.618	1.003	Sept.
Oct.	1.460	2.386	3.088	3.142	1.460	2.274	0.582	1.060	1.086	0.875	Oct.
Nov.	1.960	2.417	0.724	2.276	2.067	1.789	4.920	0.430	0.688	2.124	Nov.
Dec.	0.490	0.163	1.427	1.168	1.233	1.279	3.624	1.549	1.674	1.827	Dec.
	15.702	17.277	16.064	22.723	20.553	18.425	24.088	17.223	16.946	16.412	

Annual quantities of rain at Lyndon.

	1751	1752	1753	1754	1755	1756	1757	1758	1759	1760	
Jan.	3.098	2.518	1.692	0.925	1.021	2.016	2.144	1.867	0.876	1.062	Jan.
Feb.	0.924	1.377	1.841	0.887	0.835	0.689	0.594	2.060	0.379	1.872	Feb.
Mar.	2.046	1.203	1.172	1.247	1.657	1.370	1.905	1.792	1.874	0.452	Mar.
April	3.086	0.827	1.395	1.455	1.965	3.899	2.090	0.917	3.026	0.389	April
May	2.656	2.134	0.980	1.400	1.393	1.258	1.371	1.269	2.739	0.890	May
June	1.847	3.084	1.007	2.883	1.811	2.973	0.375	2.160	2.970	2.470	June
July	4.989	3.678	2.595	3.849	1.585	3.197	3.002	5.023	0.927	0.895	July
Aug.	1.580	1.324	3.380	1.060	2.258	4.257	6.057	1.711	3.729	1.644	Aug.
Sept.	2.614	0.280	0.706	0.107	2.546	2.080	0.518	1.465	0.854	2.333	Sept.
Oct.	1.819	0.295	1.458	1.866	1.628	1.528	1.954	1.032	1.500	2.531	Oct.
Nov.	1.338	1.090	2.112	1.960	3.138	0.975	1.498	0.912	0.980	2.134	Nov.
Dec.	1.161	3.127	3.865	2.218	1.408	0.944	2.175	1.386	1.085	1.613	Dec.
	27.158	21.147	22.203	19.857	21.245	25.186	23.683	21.594	20.939	18.285	

Annual quantities of rain at Lyndon.

	1761	1762	1763	1764	1765	1766	1767	1768	1769	1770	
Jan.	0.191	1.727	0.600	3.984	1.435	0.164	3.079	2.834	1.194	0.852	Jan.
Feb.	1.469	0.968	2.882	1.134	1.240	2.102	2.002	3.062	1.556	0.736	Feb.
Mar.	0.529	1.527	0.919	0.829	2.767	0.785	1.052	0.391	0.693	1.934	Mar.
April	0.490	0.595	0.692	1.324	2.111	1.955	0.845	2.023	0.843	1.900	April
May	2.035	0.738	2.304	1.095	0.406	3.286	2.123	1.622	1.451	1.553	May
June	3.487	0.764	2.426	2.182	0.788	2.279	2.163	4.521	4.769	2.765	June
July	0.566	1.119	3.657	4.624	0.582	2.363	3.682	2.402	1.994	1.788	July
Aug.	3.614	3.615	2.929	1.770	2.805	0.409	1.527	1.720	2.360	2.270	Aug.
Sept.	2.349	1.525	3.307	0.830	0.696	1.080	0.687	3.025	2.583	1.223	Sept.
Oct.	3.685	4.154	1.606	1.359	4.842	0.829	2.822	3.119	1.202	3.114	Oct.
Nov.	1.443	0.923	1.894	1.765	1.281	1.938	0.926	4.040	1.224	7.818	Nov.
Dec.	1.541	0.233	3.525	2.398	1.048	1.776	0.400	2.146	1.608	2.613	Dec.
	21.399	71.888	28.741	23.494	20.001	18.966	21.308	30.905	21.477	28.566	

Three driest seasons from one month to twelve.

1 Month	Sept. 43	0.008	Mar. 42	0.055	Feb. 40	0.060
2	Jan. and Feb.	0.320	Dec. 42 Jan. 43	0.569	Feb and Mar. 40	0.692
3	Dec. 42-Feb. 43	0.994	Jan. — Mar. 40	0.942	Mar. — May 41	1.279
4	Jan. — April 40	1.814	Feb. — May 41	1.897	Dec. 42-Mar. 43	2.127
5	Jan. — May 40	2.850	Jan. — May 41	2.985	Dec. 42-April 43	3.379
6	Feb. — July 41	4.136	Dec. 42-May 43	4.247	Jan. to June 40	4.280
7	Dec. 42-June 43	4.626	Jan. — July 41	5.222	Dec. 39-June 40	5.930
8	Oct. 39-May 40	6.579	Jan. — Aug. 41	6.857	Nov. 42-June 43	7.043
9	Oct. 39-June 40	8.009	Nov. 36-July 37	8.865	Sept. 59-May 60	9.084
10	Sept. 39-June 41	9.912	Oct. 40-July 37	10.274	Aug. 42-May 43	10.988
11	Aug. 42-June 43	11.367	Sept. 40-July 41	11.794	Aug. 39-June 40	12.262
12	Aug. 40-July 41	13.447	Sept. 59-Aug. 60	14.093	July 39-June 40	14.227

Three wettest seasons, from one month to twelve, except 1763, 1768, and 1770, which are below.

Month	July 36	6.550	Aug. 37	6.300	Aug. 57	6.057
	Aug. Sept. 37	9.765	July Aug. 57	9.059	July Aug. 36	9.050
3	Aug. Sept. Oct. 37	11.790	July Aug. Sept. 36	10.590	June July Aug. 56	10.427
4	July — Oct. 36	12.940	April — July 51	12.578	June — Sept. 56	12.507
5	April — Aug. 56	15.584	Mar. — July 51	14.624	Aug. — Dec. 37	14.190
6	April — Sept. 56	17.664	April — Sept. 51	16.772	Aug. 37-Jan. 38	15.978
7	April — Oct. 56	19.192	Mar. — Sept. 51	18.818	May — Nov. 61	17.179
8	Mar. — Oct. 51	20.637	Mar. — Oct. 56	20.562	July 57-Feb. 58	19.131
9	Jan. — Sept. 51	22.840	Jan. — Sept. 56	21.739	July 57-Mar. 58	20.923
10	Dec. 50-Sept. 51	24.667	Nov. 55-Aug. 56	24.205	Nov. 47-Aug. 48	22.175
11	Nov. 50-Sept. 51	26.791	Nov. 55-Sept. 56	26.285	Aug. 37-June 38	23.545
12	Nov. 50-Oct. 51	28.610	Sept. 55-Aug. 56	28.379	Aug. 57-July 58	27.290

Wetness of the Seasons in

	1763		1768		1770	
1 Month	July	5.657	June	4.521	Nov.	7.818
2	July Aug.	8.586	Oct. Nov.	7.159	Oct. Nov.	10.932
3	July — Sept.	11.893	Sept. — Nov.	10.184	Oct. — Dec.	13.545
4	June — Sept.	14.319	Sept. — Dec.	12.330	Sept. — Dec.	14.768
5	May — Sept.	16.623	June — Oct.	14.787	Aug. — Dec.	17.038
6	July — Dec.	18.918	June — Nov.	18.227	June — Nov.	18.978
7	July 63 — Jan. 64	22.902	June — Dec.	20.973	June — Dec.	21.591
8	June — Jan.	25.328	May — Dec.	22.595	May — Dec.	23.144
9	May — Jan.	27.632	April — Dec.	24.618	April — Dec.	25.044
10	May — Feb.	28.766	Feb. — Nov.	25.925	Mar. — Dec.	26.978
11	May — Mar.	29.595	Jan. — Nov.	28.759	Feb. — Dec.	27.714
12	Feb. 63 — Jan. 64	32.125	Jan. — Dec.	30.905	Jan. — Dec.	28.566

XXVIII. *A second Letter from Mr. Barker to the President, on the same Subject; together with the Determination of the Latitude of Stamford, in Lincolnshire.*

S I R,

Lyndon, June 4, 1771.

Read June 13,
1771.

I AM glad the letter I sent to you for the Royal Society, was thought worth their acceptance. I have, on the other side, sent, as you desired, the height my rain measurer stands above the ground, which, if you think proper, may be added to my former letter. Mr. Edward Lawrence, who observed the rain at Stamford part of the time which I have done here, generally found more water in his measurer which stood on the ground, than I did in mine; but I cannot depend on his observations, because I have been told the servants at the house used to play him tricks, and pour into his cistern more water than fell in, to which a thing on the ground is very liable.

Mr. Lawrence also observed the latitude of Stamford with a quadrant of Mr. Sisson's making; and as it is useful to preserve such things, I have extracted the observations from his book, and shewn the latitude deduced from them.

My rain cistern has all along stood on the top of a wall, where another meets it at right angles. The top of the cistern on the North side, is 7 feet 3 inches;

on the Southwest side, 8 feet 6 inches; and on the Southeast side, 10 feet above the ground; it is all open Southward for 25 yards; the North side is an orchard, but no tree hangs over it.

The latitude of Mr. Neal's house, at the South end of St. Martin's, adjoining to Stamford in Lincolnshire, as taken by Mr. Edward Lawrence, in 1736.

1st, By the Sun's meridian Altitude Incl. of Eclipt. $23^{\circ} 28' 20''$.

May 1. Alt.	55 37 0	June 18 Alt.	60 35 0	Aug. 7 Alt.	50 19 50
☉'s Decl. N.	18 16 15	Decl. N.	23 14 28	Decl. N.	12 59 16
Alt. of the Equat.	37 20 45	Equator	37 20 32	Equator	37 20 34
6	56 47 26 19 27 11	July 7	58 20 30 20 59 16	11	49 0 18 11 39 25
	37 20 15		37 21 14		37 20 53
13	58 24 30 21 9 10	10	57 46 53 20 25 36	18	46 34 0 9 13 7
	37 21 20		37 21 17		37 20 53
31	60 28 31 23 8 36	15	56 44 0 19 22 45	Sept. 8	38 38 30 1 18 1
	37 19 55		37 21 15		37 20 29
June 1	60 33 32 23 12 24	17	56 16 26 18 55 16	9	38 16 0 0 54 34
	37 21 8		37 21 10		37 21 26
2	60 37 2 23 15 49	20	55 33 0 18 11 50		
	37 21 13		37 21 10	greatest	37 21 26
9	60 49 0 23 28 12	26	53 58 0 16 36 56	mean	37 20 55
	37 20 48		37 21 4	least	37 19 55

2d, By the Meridian Altitude of the Pole star.

May

	° ' "		° ' "
May 14, Alt.	50 33 0	Oct. 29, below	50 33 30
below the Pole	2 5 45	above	54 44 30
Latitude	52 38 45	Latitude	52 39 0
Mean Latitude by the Sun			52 39 5
by three observations of the Pole star			52 38 55
Mean Latitude of the S. of St. Martin's			52 39 0
St. Mary's, the middle of Stamford, is half a			52 39 30
mile further North, therefore its Latitude is			

I remain, Sir,

With all proper respect,

Your humble servant,

Tho. Barker.

XXIX. *Observations on some Bivalve Insects, found in common Water, by Mr. Muller, of the new Academy of Sciences in Bavaria, and the Oeconomical Society at Bern; communicated by R. H. A. Bennet, Esq; F. R. S.*

Read April 18, 1771. **T**HE name of Bivalve is given only to those shell-fish, whose houses are composed of two parts, such as muscles and oysters. Few of these are to be met with in fresh water, whereas a vast number are inhabitants of the sea. I am acquainted with no more than four different species, like the sea bivalve; they are found in the waters of Fricksdal, near Copenhagen, and amongst them one has hitherto escaped the researches of conchiliogists.

In return, nature has liberally stocked the same waters with small insects, much more perfect than the inhabitants of the sea-shells, and likewise provided with a double shell. It is sufficiently known, that muscles and oysters are animals extremely simple; since they want several of the most perfect organs, and consequently enjoy life in an incomplete manner. The want of eyes, arms, legs, &c. obliges them to lead an idle life, deprived of all the advantages, which

which arise from fight and motion. Nature, from which they received an habitation sufficient to protect them from external injuries, seems to have fixed for life their abode to one dark spot. Our bivalve insects, on the contrary, by opening their two folding gates, enjoy both fight and motion, alternately dipping in the mud, and darting through their element the water; whenever they meet with bad company, they hide themselves in their shells, and shut up the valves, which force and distress attempt in vain to force open.

I have discovered several different species of these animals in the waters of Fridericksdal, one only of which is known to the naturalists. Mr. Baker, of the Royal Society of London, is the first, that I know of, who mentions it; “ he says *, that the “ insect swims very fast; that it procures its nourishment by means of a whirlpool, which it raises in “ the water by means of its arms; that, upon meeting with a solid body, it stops itself by means of “ its feet; that upon the slightest touch it shrinks into “ its shell; and lastly that it bears much resemblance “ to a bivalve shell-fish.” To this description he joins a figure, which, though imperfect †, represents the insect. *Linnaeus* ‡, and *Geoffroi* || call it the *Monocle*, and without taking notice that Mr. Baker knew it already, they observe that its *antennae* are composed of small white threads; and that the shell is oblong, smooth, and greyish, round on one side, flat on the

* Microscope made easy.

† Tab. XV. f. viii.

‡ *Fauna Suecica*, 1761; 2060.

|| *Histoire des Insectes*, tom. ii. p. 657. 4°.

other, and nearly of the same size at each end. None of the above-mentioned writers have had the satisfaction of inspecting the inhabitant of the shell, which indeed is very difficult. Now as this insect bears a strong likeness to the new species, which I am about to describe, we shall take a view of both together.

As I was walking in the month of November 1767 along the shore, out of the Western gate of Copenhagen, I saw in a ditch of fresh water, a *conferva* *, which I carried home with me. I immediately put a lump of it to dry upon the stove; after which, upon looking at it through a glass, I discovered here and there several small white points, very smooth and shining. These I took up upon the point of a pin, and on a closer view found them to be two valved shells hardly discernible. The hinge, together with the opening and figure of them, justified my opinion. I separated the valves, and the rising part of the hinge to the edge shewed them to be shells. I regretted that the insect, a sight of which was absolutely necessary to rank them among the testaceous kind, had been destroyed by the heat of the stove. The frost came on, and prevented my making any further enquiries. I shewed my shells to three naturalists of known abilities, who agreed in assuring me that they were of the muscle kind. I had still some doubt arising from the recollection of the insect above-mentioned †, which I had found formerly: and I put off the decision, till

* Flora Fridricksdalins, 1016.

† Fauna Fridricksd. 851.

I had seen the inhabitant alive. In the beginning of April 1768, as soon as the frost broke, I got some more of the *conservas*, which I dissolved in a glass of water without discovering the bivalve; nor had I any better success upon trying the effect of the stove. During the spring, I continued my search in the country, and found several species of bivalve insects, which led me to think the inhabitant of the shell was like them. At last, in autumn, after I had given up my hopes, I found it in the Park, at the bottom of a ditch full of standing waters. The transparency of the shell gave me an opportunity of examining the inhabitant; and the examination cleared up the doubt I had about its species.

The new shell is a bivalve; white, smooth, shining, and transparent, without the least spot, hair, or down. Its figure is oblong, rounded at both ends, and the hinge somewhat sinuated at the opening, and convex at the sides, in such a manner as, when seen out of water, it is very like the seeds of some plants; and this is common to all the species of this genus. The substance is coriaceous, or like hardened glue; thin, and very brittle when dried. When seen by the microscope, some of them appear very like net work. The valves are equal, a little broader at one end than at the other, and somewhat flattened at the slope; they are not however more elevated at the opening than at the hinge, but rather the contrary; for on the inside they shew another edge, less elevated than that of the outside, and which grows less and less towards the hinge. I call by this name the place, where the valves join, though I have not been able to discover either the membrane or teeth;

which seem to shut the valves in common shells. They are however strictly joined to this place during the animal's life; which makes one think there is a ligament at the tail of the inhabitant, by which he shuts himself in. The length of the shell is half a line, and its greater breadth above a quarter of a line. That species mentioned by the above writers is three times longer before it comes to its full growth. It is hairy, though smooth to the naked eye, more indented at the slopes where the valves are projecting, and more depressed towards the hinge; it is opaque, and of a changeable colour. Some of these insects are of a light and others of a dark green, marked with an oblique stripe of a lighter than the rest. Some of these are bright, and others grey and dirty; but the down with which the shell is covered, and to which the dirt sticks, is only visible with the microscope. I have examined several of these, at different ages, and at different times of the year, and have found them all rough; whereas every one of those of the new species is smooth. I shall call this new species the *white smooth* bivalve, to distinguish it from another, the shell of which is white and rough; and from that of the above mentioned authors, which I call the *sordid*, in allusion to the dirty shell in which it is often found.

I have already observed how difficult it is to discover the shape of the inhabitants of these bivalves: however, the transparency of the *smooth white* one, gave me an opportunity of examining the lateral part of its inhabitant with the microscope; and a happy accident, by which I caught the *sordid* one at rest upon the back of its own valves, enabled

abled me to examine its fore part through a glass. I suspect that it was shedding its skin, and for this reason was quieter, and had its valves more open than usually; be that as it will, I shall now describe the remarkable animal I observed.

The head is broad towards the bottom, but decreases gradually in bulk, and terminates in a tapering point; it has on each side a small long white thread, in the form of *antennæ*. The animal seems to lower and raise the point at pleasure.

The *antennæ*, are about the length of the shell, and rest on a transparent cylindrical basis, which ends in white long capillary filaments. They appear to be stuck on at the extremity of the head, but in fact are tied to the sides, as I have often observed the animal to lower the point of its head towards its breast, without the *antennæ* following the motion. The *smooth white* bivalve has five capillary threads at each *antenna*, four of which are at top, and the fifth somewhat lower. The *fordid* appears to have ten at each *antenna*; in several, the *antennæ* appear yellowish, and their basis seems to consist of four rings.

It is by means of these *antennæ*, which are real fins, that the animal changes its position, from one place to another, being able to move them several ways; when it has a mind to move fast, they are first extended straightways, and appear like two bristles; in an instant the threads are unfolded, and the animal swims with great quickness. As for walking, it sometimes joins the threads, sometimes unfolds only a single one, and sometimes scatters them about all together; sometimes it bands them between the

valves, which are opened towards the place of the eye; it often hides one or both of them under the breast between the four legs; these *antennæ* seem to afford as great an amusement to the animal, as they do to the spectators.

At the place where the head joins the body, towards the border of the hinge of the shell, one may perceive a little black spot, which is the animal's eye. This extraordinary situation of the organ of sight upon the neck seems astonishing; every thing that is new is so, but the surprize arises only from the narrowness of our ideas. Many people would give very specious reasons for this position; others might suppose, that if the Creator had consulted us upon the matter, the eyes should have been placed in a quite contrary position, towards the extremity of the head. How childish and weak would this be! What God does, is undoubtedly most perfect; and what he orders the best possible: but what we term final causes, are seldom any more than conjectures, though sometimes they happen unexpectedly to be true. Some aquatic insects have the eye in the forehead, others at the bottom, on the fore or back part of the head, at the side or under it; nay there are some, whose head consists of the eye only. The plain reason to be given of the different positions of the principal organs, is at the same time the most probable, or at least the most within our compass. The Governor of the world is pleased to give infinite variety to his works, and only observes the laws of uniformity in the generation of each distinct species.

The breast jets out a good deal towards the opening of the shell, and constitutes the greater part of the animal's body. The feet, mouth, and little bristles are placed upon it.

There are four feet, whose position resembles a good deal that of quadrupeds, only that their reciprocal bent is more marked. The two foremost are at the top of the breast, in the part where it appears most sloped. I took them a great while for feelers, because the animal employs them to touch things with; but another use it makes of them, together with the discovery of some true bristles, makes me judge them to be legs. They are white, transparent, and jointed, bent towards the back legs, and terminated by two points in the shape of claws. The joints have very thin hair on the inferior part. The two hind legs are tied to the lower part of the breast. They are longer than the fore legs. Each joint has a couple of small threads at the end, and each leg terminates in a claw somewhat lengthened; as to the rest, they are like the fore legs, and bend towards them.

The bivalve insect makes use of its claws, not only to walk upon the *conserua*, some parts of which are true labyrinths, and others forests to him; but likewise to remove the dirt, to seize its prey, and to fasten itself to other animals of its kind, or to neighbouring bodies.

Under the breast, and near the fore feet, is a black spot, which is the insect's mouth; it is covered with a small transparent skin, which opens in the middle, and shews a couple of jaws, marked with a very black spot at the place where they join. Between these jaws hang very small white beards like those

those of the *tipula*; and above these again, there appears a small black transversal line. About the mouth there are several other little beards, somewhat in the shape of feet, which are constantly in motion.

There is no doubt but that these serve to procure a free passage to the water, and to carry the food to the animal's mouth; which employment we can by no means assign to the hinder legs, as Mr. Baker, who did not see the parts concealed between the valves of the shell, has done.

The belly is almost as broad as the breast, but has scarce above half its length. The breadth decreases towards the tail. When seen from before, the belly appears composed of two conical lobes, marked in the middle with a black circle. It moves alternately to, and retires from, the breast.

The tail comes out between these two lobes; it is of the same length with the body, and consists of two streight white and transparent canals, which are joined together till towards the end, where they separate, and each terminates in two curved points. Towards the middle of the tail, there is a little hard bristle, upon each of the canals. The animal commonly keeps this hid under his breast and belly; nor have I ever seen it extend it, unless when upon the point of wanting the necessary water, when the animal brings it out, to put himself in an easier situation; after which, it is immediately drawn in back again.

Upon the back of the insect, are likewise seen two large round bodies, which I take to be the *ovaria*.

No body, after this description, will dispute the superiority which our bivalve insect has over the bivalve shell-fish,

shell-fish, by the wonderful construction of its body, and the advantages which arise from it. But the difference of make is not the only one, since the shell too is formed in a quite different manner.

The several hypotheses of naturalists, on the formation of shells, are known; some will have them increase by *intussusception*, and others by *juxtaposition*. This latter opinion, which M. de Reaumur patronized, and which nature seemed to justify, became, in consequence, the most general; but if the friends of the other system were thought to lose their cause, it was only for want of observing with a sufficient degree of accuracy the operations of nature, whose variety would have furnished them with instances in their favour. Our bivalve insect offers one, which the desertion of the old shell and the formation of a new one, in proportion as the animal grows, put beyond a doubt. The fact itself appears, not only from the observation of empty shells of different sizes, which are to be met with in waters, and are nothing more than the spoils of our bivalve insects; but, from the singular good fortune I had, in seeing one of the animals strip itself, entirely, in my presence, of the membrane of its shell, and of the exterior parts of its body, and shew itself as last before me absolutely renewed. The *exuvie* both of the shell and the animal's body were transparent as the brightest crystal. The joints of the *antennæ*, the bristles, the feet, the smallest hairs, were more distinguishable than in the animal itself. How infinitely small are the organs, which, hid as it were in sheaths and cases, only become visible when they are magnified some thousands of times! and how many are there which escape the best microscope!

In the clearest water that we drink, one can often see with the naked eye spoils of this insect, joined to those of its shell, floating along, like fine white cotton.

This adhesion proves that the body of the animal is joined to the shell by some ligaments, which possibly too may keep the valves to the hinge, as I conjectured above.

I have not yet succeeded in discovering the organs of generation ; nor have I seen the insects in the act of copulation (which cannot be less extraordinary than that of the other species of the *monoculi*) : so that I can say nothing of their sex. I have observed that they lay eggs, but this does not prevent their being likewise viviparous : I have seen other species of *monoculi*, some of which had their *ovaria* full of eggs, and others of little live beasts, which at times they hatched, and at others put down in the shell.

The *sordid* species is the most commonly met with ; one finds it all the year, even in the time of frost, from under which I have often drawn it.

It is found in all pure waters, and even in the little ditches which are exposed to be overflowed by the sea. I have preserved it from May to November, full of life and motion, in a glass of water, which I did not renew the whole time.

The *smooth white* insect lives at the bottom of marshes, and pools, in which the *conferua* I have mentioned grows.

As the entomologists have ranked the bivalve insects under the genus of the *monoculi*, I am naturally led to say something about this genus.

Systematical writers have confounded aquatic insects, very different, both in species and genus, under the general arbitrary name of *Monoculus*. They have not been contented with giving the same denomination to several species, whose properties and attributes did not at all correspond with the known characters of the genus, but have likewise given as specific marks those which nature tells us are generic. I shall only mention at present the *sordid*, which furnishes me with a striking example. M. Geoffroy, as well as Linnæus, has ranked it under the genus of the *monoculi*. According to the latter, the generic character of this, is to have two eyes and twelve feet, six of which are fixed; whereas the former gives it only one eye and six feet. Besides the difference as to the number of eyes, my description proves that the number of feet does not agree with this account. Let me add, that the particular make of the *antennæ*, the feet, the tail, and the whole body, give this insect a claim to form a genus of its own. As to the specific definition, *Antennis multiplicibus capillaceis, testa bivalvi*, and whatever else is said of it, if one excepts the colour only, belong equally to all my species with capillary *antennæ*, and constitute rather a definition of the whole genus, than of a particular species.

The same mistake is to be met with in several other species brought under this genus; and the reason of it is that the authors, not having known more than four of all the different species, which I have reckoned up in the following table, have generalized the characters of these four, though they were not well acquainted even with these.

The *water parrot*, which is the best known, both on account of its colour, sometimes red, which makes the vulgar believe that the water is changed into blood, and from the works of *Shæffer Baker*, *Geoffroy*, and *Swammerdam*, is represented by the latter as hermaphrodite, though it be different in sex, and have the parts of generation double.

The knowledge of these insects has been almost entirely neglected, though in reality very interesting; not to speak of their wonderful make, the difference of their motion, and their singular mode of copulation, are worthy of our enquiries. Let it be sufficient to say, that we swallow them and their shells, either living or dead, both in our victuals and drink; so that I should not be surprized, if some time or other they were found in our intestines, or in those of beasts, and several of our diseases attributed to them.

I propose giving the description and history of these insects, with their figures drawn to the life, as seen by the microscope: this I shall do in a work which I am projecting. To render it more compleat, I beg the favour of all naturalists to communicate their observations, which I shall not omit to give them the credit of, and at the same time, if they should find any other species, to send them to me. It is very easy to transport these insects, as they live very well in a small quantity of water for several weeks, without a necessity of a change. With these hopes I have added a list of the several species, which I have met with in the waters of *Friderikstall*. It is after having examined and compared them, at different intervals, at all ages, and in all seasons of the year, that I venture to pronounce upon their specific differences.

I shall

I shall take another opportunity of fixing the general ones.

GENS MONOCULORUM,

aquarum Friderichsdalensium.

a Conchacei.

* Antennis capillaribus superis : capite abscondito.

1. Antennis binis : testa ovata, tomentosa. Fig. IV, V, VI.

2. Antennis binis : testa ovata fusca, ciliata.

3. Antennis binis : testa subovata, candidissima.

4. Antennis binis : testa reniformi, pellucida. Fig. I, II, III.

5. Antennis binis : testa subreniformi, fusca : fasciis tribus albis.

6. Antennis binis : testa elongata ; fascia viridi.

7. Antennis binis : testa antice truncata : strigis nigris.

8. Antennis binis : testa globosa, glaberrima.

9. Antennis binis : testa globosa, fasciis tribus nigris.

** Antennis capillaribus inferis : capite exserto.

10. Antennis binis : cauda inflexa : testa globosa.

11. Antennis binis : cauda inflexa : testa oblonga.

~~12. B. D. Duas tantum antennis omni ratione prospicere
licuit, etiam si quatuor adesse vix dubitem.~~

12. Antennis quaternis : cauda truncata : testa globosa.

13. Antennis quaternis: cauda inflexa lamellata: testa ventricosa.
14. Antennis quaternis: cauda erecta: testa elongata.
15. Antennis quaternis: cauda inflexa: testa antice aculeata.
16. Antennis quaternis: cauda inflexa ferrulata: testa ventricosa, mutica.
17. Antennis quaternis: cauda recta: testa univalvi.
N.B. Hi potius binoculi & ultimus quidem proprii generis.

*** Antennis ramosis: capite manifesto.

18. Antennis dichotomis: cauda inflexa: testa sub-rhombea mutica.
Pulex non caudatus Schæff. monog. t. 1. f. 9.
19. Antennis dichotomis: cauda inflexa: testa gibba quadrangulata.
20. Antennis dichotomis: cauda inflexa verrucosa: testa postice aculeata.
Pulex caudatus Schæff. monog. t. 1. f. 1—8.
21. Antennis dichotomis: cauda inflexa: testa antice ferrulata, postice aculeo longo.
22. Antennis dichotomis: cauda inflexa: testa antice ciliata: corniculis porrectis longis.
23. Antennis dichotomis: cauda inflexa: testa antice pilosa: corniculis pendulis.
24. Antennis dichotomis: cauda inflexa appendiculata: testa postice acuta.
25. Antennis dichotomis: cauda inflexa appendiculata: testa antice aculeata.
26. Antennis dichotomis: cauda deflexa: testa mutica: corniculis porrectis brevibus.

27. An-

Fig. I. ♂



Fig. II. ♀



Fig. III. ♂



Fig. IV. ♀



Fig. V. ♂



Fig. VI. ♀



Fig. VII.



27. Antennis dichotomis: cauda recta: testa ovata mutica.

28. Antennis trichotomis: cauda recta: testa angulis anticis fetiferis.

b Cataphracti.

* Antennis binis.

29. Antennis binis simplicibus: cauda recta bifurca.

30. Antennis binis simplicibus: cauda curva bifurca, laciniis pendulis.

31. Antennis binis simplicibus: cauda bifeta.

32. Antennis binis simplicibus rigidis: cauda bifida.

33. Antennis binis dichotomis: cauda inflexa.

** Antennis quaternis.

34. Antennis quaternis simplicibus: cauda recta bifida.

Baker microscop. t. 15. f. 1—4.

Hafniz, 24 Nov. 1768.

Otto Fridericus Müller.

Acad. Cæs. N.C. Scientiarum Boicæ,
ac Societ. Oecon. Bernens.

Explanation of the Bivalve Insect, TAB. VII.

Fig. I. The smooth white insect as it is naturally.

Fig. II. The same, seen through the magnifier.

Fig. III. The same magnified by the microscope.

The transparent shell shews the inhabitant lying at its full length; with the *antenna*, legs and tail, out of the valves.

a The edges of the two valves.

b The *antenna*.

c The eye.

d The

- d* The head.
- e* The *ovaria*.
- f* The fore legs.
- g* The hind legs.
- h* The tail.
- i* The fore part of the breast, where the beards
and mouth are placed.
- k* The belly.

Fig. IV. The *fordid* shell of its natural size.

Fig. V. The same, as seen through the glass.

Fig. VI. The same, with the shell a little opened, and
more magnified.

- a* The rough shell.
- b* The oblique stripe.
- c* The *antennæ*.
- d* The fore legs.
- e* The hind legs.
- f* The mouth and joints.
- g* The tail.

Fig. VII. The same, with the shell shut.

XXX. *A Letter to the Rev. M. Lort, B. D.
F. R. S. containing an Account of a singular
Fish, from the South Seas, by the
Rev. Mr. Michael Tyfon.*

Reverend Sir,

Read May 9, 1771. **T**HE Rev. Mr. Farmer, Fellow of Emanuel college, Cambridge, very obligingly lent me a curious fish, preserved in spirits, which was brought by his relation Commodore Byron, from the new-discovered islands in the South Sea. As I have the greatest reason to believe that it has never been figured or described by any author, and indeed never before seen in Europe; I have taken the liberty to send you the following description and drawing of it (TAB. VII. fig. VIII.). I could not count the branchiostegous rays, without greatly injuring the specimen; but there is no doubt of its being one of the *Perca* genus of Linnæus. It is called by the Commodore the *Zebra* fish, he not knowing its proper name. The drawing is exactly measured from the real fish, and is in every part of the same size.

Piscis thoracicus.

Perca * * * * *

CAPUT obtusum, anticè nudum. Os ascensum, labiis carnosiss marginatum, mandibula inferiore longiore. Dentes in maxillâ utrâque æquales, acerosi, approximati. Sutura maxillarum utrinque obliqua, dentata.

Opercula branchiarum spinis ferrato-ciliata. Nares unicæ, rotundæ, marginatæ.

Corpus ovatum, compressum, squamosum.

Pinnæ basi squamosæ, margine nigræ, ramentis ultra radios porrectis. Dorsales 2 subunitæ: prima, rotundata, radiis 10 spinosis, secunda angulata, radiis 16 mollibus. Pectorales rotundatæ radiis 14. Ventrals radiis 6. Analis angulata radiis 14, anticis 2 spinosis. Caudalis rotundata 18.

Color griseus. Fasciæ 6 nigræ transversæ totum piscem cingunt: prima per caput ducitur, pone oculos; secunda per operculorum marginem; tertia angulata, obliqua, inter pinnam primam dorsi atque anum; quarta recta ab unione pinnarum dorsalium ad spatium pone anum; quinta arcuata inter pinnam dorsalem secundam et pinnam analem; sexta rectiuscula in basi pinnæ caudalis.

Diagnosis.

Diagnosis.

Perca (****) *Pinnis dorsalis subunitis, caudâ rotundatâ, corpore ovato: fasciis 6 transversis nigris.*

I am,

REVEREND SIR,

Your most obedient

humble servant,

Bennet Coll. Camb.
March 11, 1771.

Michael Tyson.

XXXI. *An Account of Elden Hole in Derbyshire ; By J. Lloyd, Esq; with some Observations upon it, by Edward King, Esq; F. R. S. ; in a Letter to Matthew Maty, M. D. Sec. R. S.*

To Edward King, Esq;

Dear Sir,

Read Feb. 21, 1771. **T**HE inclosed is some account of Elden Hole, in Derbyshire ; with the observations I made, upon being let down into it, in June last, at the time I was at Buxton-wells. If you think it any way curious, as a new account, you will be pleased to communicate it to the Royal Society.

I am, Dear Sir,

Your much obliged

humble servant,

Soughton in Flintshire,
August 4, 1770.

J. Lloyd.

A De-

A Description

OF ELDEN HOLE, in DERBYSHIRE.

HAVING often heard, and seen, several accounts of the unfathomable depth of Elden Hole, in Derbyshire, and being in that neighbourhood, I was inclined to make what enquiries I could about that noted place, of the adjoining inhabitants; who informed me, that about fourteen or fifteen years ago, the owner of the pasture in which this chasm is situated, having lost several cattle, had agreed with two men for to fill it up; but they, finding no visible effects of their labour, after having spent some days in throwing down many loads of stones, ventured to be let down into it, to see if their undertaking was practicable; when upon finding at the bottom a prodigious large cavern, they desisted from their work, as it would have been almost impossible to have procured a sufficient quantity of stones to have filled it up.

Upon enquiry of one of these men whether there were any damp's at the bottom; and being assured in the negative; I procured two ropes of forty fathom nearly in length, and eight men to let me down.

As the entrance is so well known, I shall say nothing further of it, than merely, that it lies near North and South in its direction lengthways; and that the opening from one of those points to the other, at

the surface, is about thirty yards, and eight or nine yards broad.

For the first twenty yards I was let down (which was at the South side), I could assist myself with my hands and feet, as it was a kind of confined slope; but after that, the rock jetted out into large irregular pieces, on all the three sides next me; and on that account I met with some difficulty in passing, for about the space of ten yards more; at which depth the rope was moved at least five or six yards from the perpendicular. Thence down, the breadth was about three yards, and the length at least five or six, through craggy irregular flits in the rock, which was rather dirty, and covered with a kind of moss, and pretty wet, until I came within about twelve or fourteen yards of the bottom, and then the rock opened on the East side, and I swung, till I descended to the floor of the cave, where I perceived there was light enough came from the mouth of the pit (though at the distance of sixty-two perpendicular yards) to read any print. When I was at the bottom, I perceived that the cavern consisted of two parts; the first (into which I descended, at the place I began to swing) being a cave; in shape not much unlike to that of an oven; and the latter, a vast dome of the form of the inside of a glass-house; with a small arched passage from the one to the other, through which a slope of loose stones (that have been thrown in from time to time) extends from the wall at the West side of the first dome, to almost the bottom of the second cave, or dome, with such an angle, that the further end of the cave is lower by twenty-five yards, than the place where I first landed.

The

The diameter of this cavern I take to be nearly fifty yards: the top I could not trace with my eye; but had reason to believe it extended to a prodigious height; for, when I was nearly at the top of one of the incrusted rocks, at the height of (I dare say) twenty yards, I could find no closure of the dome, though I then saw much further than when I stood at the bottom.

As to the particular curiosities to be met with in the small cavern, they are not worth mentioning; indeed I did not meet there with any stalactitical incrustations whatsoever; but the wall consisted of rude and irregular fragments of rock.

Amongst the singularities in the second cavern, I particularly observed the following; climbing up a few loose stones on the South side, at the place marked Q. (in the plan fig. II.), I descended again, through a small slit, into a little cave, four yards long, and irregular, as to height not exceeding two yards; and the whole lined with a kind of sparkling stalactites, of a fine deep yellow colour, with some small stalactitical drops hanging from the roof.

Facing the first entrance is a most noble column, of the same kind of incrustation (see D. fig. II. and IV.) which I could perceive to be above thirty yards high: and proceeding on to the North, I came to a large stone (marked E. fig. II. and IV.) covered with the like matter; and under it I found a hole two yards deep, lined with the same; from whence sprung a rock, consisting of vast solid round masses, like the former in colour, though not in figure, on which I easily ascended to the height of twenty yards, and got some fine pieces of stalactites, pendent from the cragged sides which joined this rock. At the upper part I perceived

perceived a small hole, or cleft; but could not, without being in danger of my life, get at it; and I found great difficulty in coming down again.

After this, proceeding forward, I came to another pile of incrustations, different from the two former, and much rougher; and which was not tinged with such a yellow, but rather with a brown colour; and at the top of this also is a small cavern, into which I went.

The last thing I took notice of was the vast drops of stalactites, hanging like icicles from every part of the vault; some of which were as large as a man's body, and at least four or five feet long.

I observed the greatest part of the walls of the large cavern was lined with incrustations, and that they were of three kinds: the first, being the deep yellow stalactites; the second, being a thin coating, like a kind of light stone-coloured varnish upon the surface of the limestone, and which glittered exceedingly by the light of the candles; and the third being a sort of rough efflorescence, every minute shoot resembling a kind of rose-flower.

Having satisfied my curiosity with a view of this astonishing vault, I began to return (observing the whole floor to be covered with vast quantities of loose stones); and reascending that heap, which I first mentioned, and so returning through the arch which separated the two vaults, I perceived, that though it is now only about three yards high, yet it must formerly (before the stones were flung in), have been a very magnificent entrance.

Once more fastening the rope to my body, I gave the signal to be drawn up, which I found to be a much more difficult and dangerous task than my
descent,

descent, owing to my weight drawing the rope into clefts, betwixt the fragments of the rock, which made it stick; and to my body jarring against the sides, which I could not possibly prevent with my hands. Another circumstance also increased the danger, which was, the rope loosening the stones over my head, whose fall I every instant dreaded. As I was obliged to keep my face towards the side on which I was let down, I could not make any very particular observations on either of the rocks on each side of me, nor any whatsoever on the opposite one, except at a few resting places, either in my descent or ascent.

For the sake of conveying a clearer idea of the description, I have added two or three drawings, and a plan; which are as exact a resemblance of the place, as my recollection will enable me to give.

And, before I conclude, I ought to mention, that under the projection of the rock at A (fig. I.) where the passage first grows narrow, and which may with difficulty be seen from the top, is the entrance of a cavern, that seems to go a great way; but I could not get into it, and therefore am not able to say any thing further about it.

P. S. Since writing the above, I have been informed, that a gentleman, who lives near the spot, affirms, there was formerly the mouth of a second shaft in the floor of the great cavern, somewhere under the great heap of stones; and that it was covered up by the miners, at the time when so many loads were thrown in from the top. It is reported to have gone down a vast depth further, and to have had water at the

the bottom; but I did not perceive any remaining appearance of such opening myself, nor did the miners, who went down with me, say any thing about it.

To Doctor Maty, Sec. R. S.

S I R,

Bedford-Row, Sept. 1, 1770.

I Have taken the liberty to send you, in consequence of Mr. Lloyd's request, his curious and exact account of Elden Hole in Derbyshire: and I hope it will not be thought improper, if I venture to add a few short observations upon it.

Mr. Lloyd, in his postscript, mentions the report of there being a second shaft, at the bottom of the great heap of stones: and when I was myself in Derbyshire, about four years ago, and went to view the spot, I had an opportunity of receiving some information, from the wife of one of the miners, who had been down; and she described the cavern in a manner agreeable to such an account: for she mentioned a very steep shelf, or descent, in the midway; at the bottom of which (she said) her husband went down again a great way further, till he came to some water.

I do therefore conclude, that there really is such a second shaft; which having been covered up with large

large flag stones, or timber (probably by the miners) to facilitate, if possible, the filling up of Elden Hole, still remains buried under the heap of stones. And I do also suppose, that the great slope of stones, which Mr. Lloyd describes, is not entirely composed of loose stones from time to time flung in; but that under them is the original shelf of solid rock, much steeper than the present slope, and something in the direction S D fig. V. with the mouth of the second shaft near the end of it. And this supposition, together with Mr. Lloyd's exact description of the parts of the cavern which he saw, will perhaps reconcile all the accounts that have been given of this most astonishing chasm.

For, stones flung down, or let down by ropes, in a proper direction, would certainly slide along the shelf of rock, and descend into the second shaft, before it was covered up; whereas others would rest at the bottom of the first shaft, or in the great cave: and hence the depths observed by different persons, at different times, must have varied greatly from one another,

And if it be further considered, that, in sounding such great depths, the weight of the rope may often be mistaken for the weight of the plummet; and that hence the rope may continue descending, and coiling up, first at the bottom, and afterwards at other places where it is accidentally stopped, till it be at length hindered in its descent by some projections of the rock nearer the mouth of the shaft; this will account for Mr. Cotton's letting down 884 yards; whilst the water at the bottom of the second shaft will account for 80 yards being wet; as so many

might coil up in the water (let it have been ever so shallow), and as the rest, beyond the real depth of the chasm, might coil up either in the great or little cave.

Again, the many craggs on each side the first shaft, (and probably also on each side the second) must retard any stone in its fall; and by that means will account for the length of time a body takes in descending; which must be a great deal longer than if it fell in open space: and hence Dr. Short (who has given us a calculation, formed from the time of the descent of heavy bodies, according to the Newtonian principles of gravitation) was misled to conclude, though very ingeniously, that this chasm was 422 yards deep.

And lastly; the falling of stones into the water, at the bottom of the second shaft, and the increase of the sound made thereby, partly from the reverberation at the sides of the great cavern, and partly from the form of the upper shaft (which is not very unlike that of a speaking trumpet, see fig. E) might occasion that astonishing noise, which is said to have been heard at various times formerly, on throwing stones into this gulph; but which has not been heard of late years, in a manner at all agreeable to old reports.

And now, Sir, I cannot forbear to take notice, that as both Mr. Lloyd, and also the miner's wife, from whom I had my information, mentioned there being water at the bottom of the second shaft, it appears highly probable, that this water is the continuation of a subterraneous river; and indeed of that very river which runs out of the mouth of the great cavern.

cavern at Castleton : for it is observed by the country-people in the neighbourhood, that there is a large quantity of grit stone grows in the earth near Elden Hole, but none near Castleton ; and yet, on high floods, the river at Castleton washes great quantities of fragments of that very grit-stone, out of the mouth of Castleton cavern.

There is also a tradition, which, however ridiculous it appears at first sight, ought to have some little weight ; especially if compared with what Keysser and Dr. Brown * relate of the Zirchnitzer sea in Carniola. The tradition is this, that many years ago, a poor old woman, hunting her goose, it fled from her, and at last fell down into Elden Hole, to her great sorrow ; but some days after, she heard it was seen at the mouth of Castleton cavern, and actually received it safe again from thence : the goose having, by the fluttering of its wings, preserved itself from being dashed to pieces in its fall ; and having found its passage safely through the subterraneous river.

I have added these few observations, for the sake of preserving the tradition concerning the second shaft, which otherwise perhaps would very soon be lost ; and also for the sake of shewing how great a probability there is of its being true : and to explain the matter more fully, I have ventured to add a fifth drawing, though merely from conjecture.

But before I conclude, I must beg leave to observe, that the disposition of the masses of stalactites in this cavern, seems to me to deserve some attention. Of the three great piles of incrustations, two manifestly

* See Keysser's *Travels* 8vo. Vol. IV. p. 140, and Lowthorp's *Abridgement of the Philosophical Transactions*, Vol. II. p. 306.

descend from two chasms (H and G fig. IV.) in the sides of the cavern; and therefore seem to have been formed by the water draining, and dripping at times, through those chasms, and carrying with it the stalactitical matter: and it is remarkable that the pile (I, Fig. IV.) from the larger chasm, is coarser, and rougher, and of a more earthy colour, than that from the smaller chasm. But the third and largest column of stalactites, (D, Fig. IV.) has no chasm in the rock at its top; and is of a finer kind than the two others; and consists of perpendicular spires; whereas the others consist of large mis-shapen lumps. And it is most remarkable, that this stands very near the end of the slope of stones; and consequently, that somewhere near it must be the mouth of the second shaft, if such really exists.

As therefore Dr. Browne, in his travels (p. 96, 4to.) mentions stalactites formed on the irons in the cupola of the baths at Buda, by the *exhalations* from the baths; and as so many of the waters in Derbyshire are warm, and mineral; I would beg leave to submit it to the consideration of the curious, whether this column, in particular, and the thin coating of stalactites, on all the walls of the great cavern, mentioned by Mr. Lloyd, were not most probably formed by *exhalations* from the second shaft; whilst the other two columns, and the stalactites pendent from the roof, were formed by water and stalactitical matter transuding through the chasms above-mentioned, and through the pores of the stone? I am, Sir,

With great respect, your much obliged,
and most obedient humble servant,

Edward King.

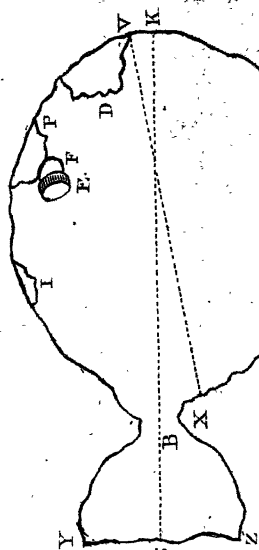


Fig. II.

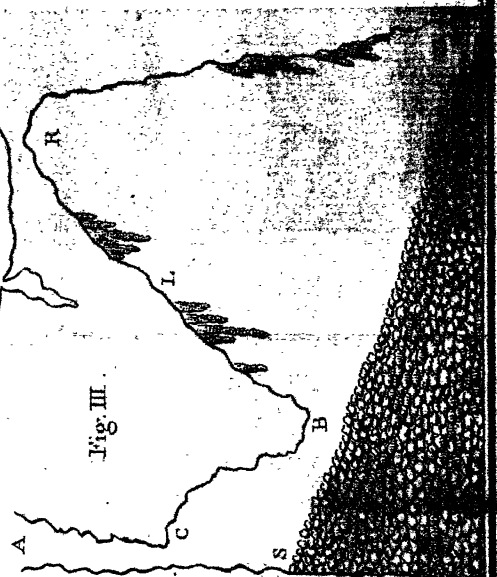
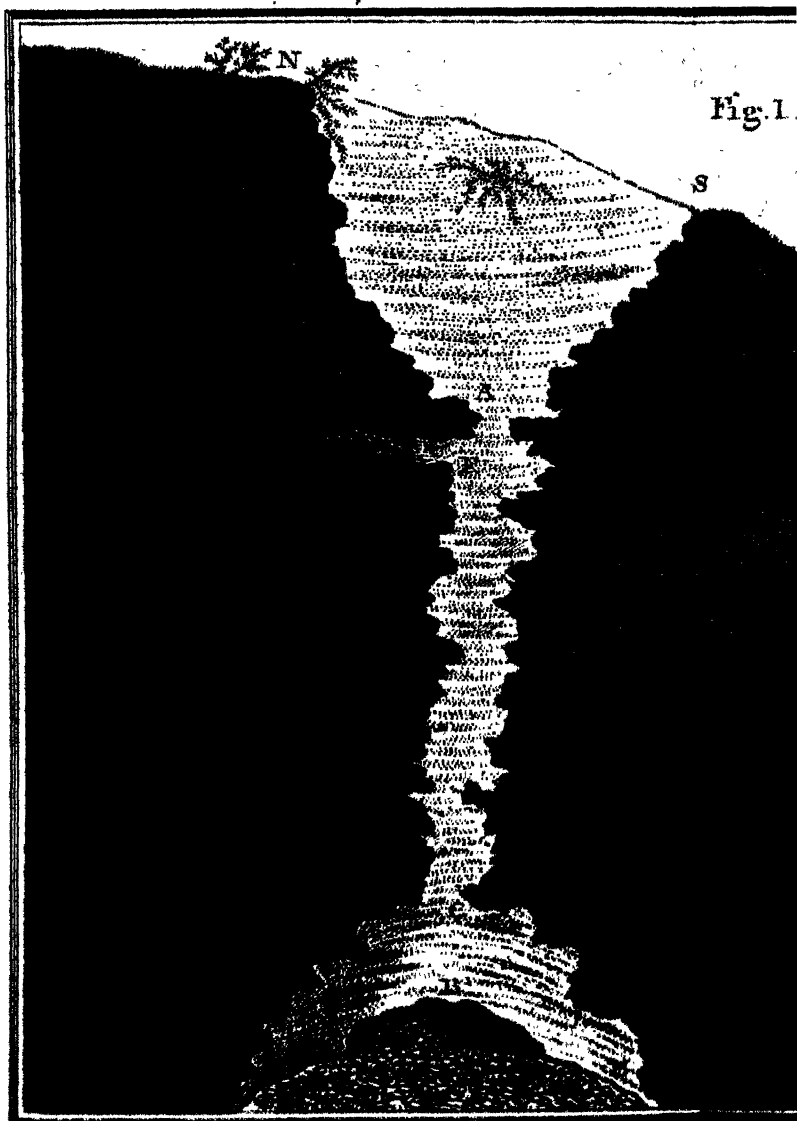


Fig. III.



Explanation of PLATE VIII.

Fig. I.

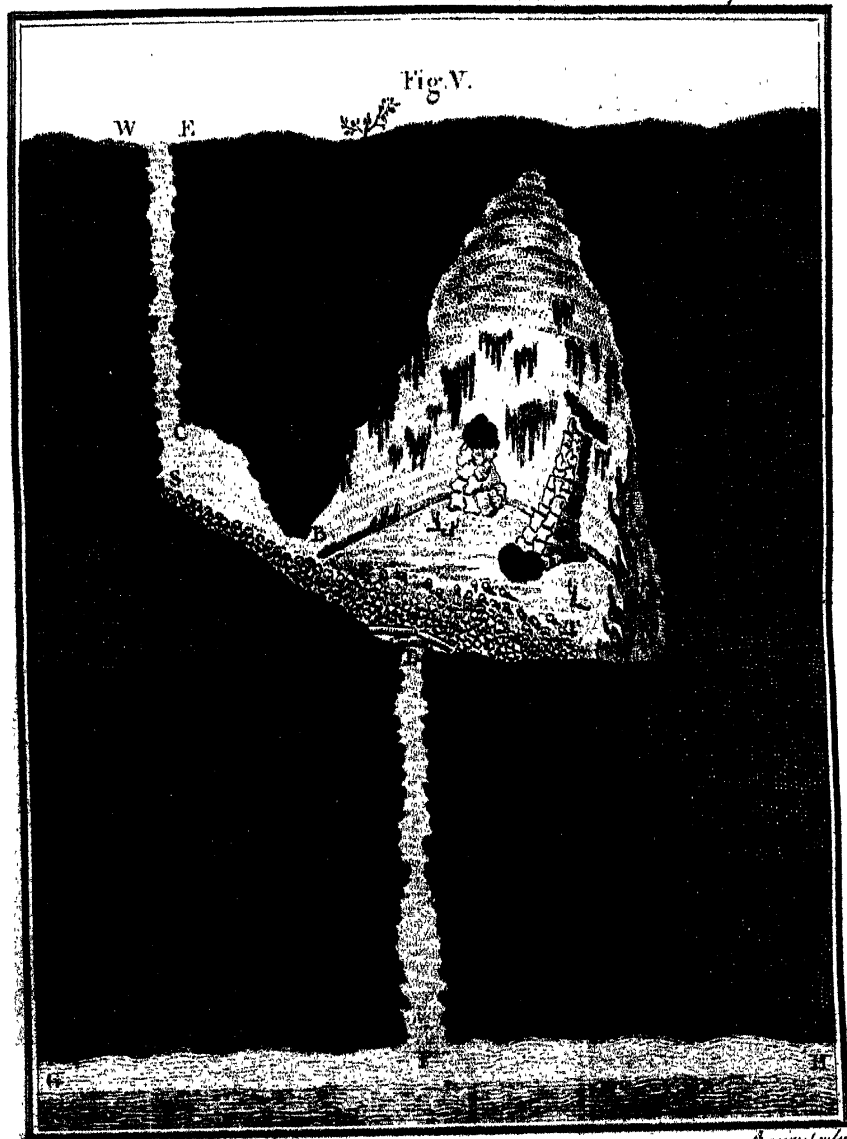
A Section of the Great Shaft, and First Cave.

- NS The mouth of the Chasm lengthways from
 North to South.
- S The South end, at which I was let down.
- A The first great cragg, where the passage
 grows narrow. Opposite to it is a large
 projection of the rock, which may be
 just seen from the top: and under that
 is,
- F The entrance of a cavern, which seemed
 to go a great way; but I could not get
 into it.
- C A large projection of the rock, at the bottom
 of the shaft. As soon as I had passed
 this, I swung; being come into the first
 Cave,
- DE The heap of stones, with which the whole
 bottom of the first cave is filled.
- B The arched passage into the great vault,
 being about three yards high.

Fig. II.

The Plan of the Caves.

- YZB** The floor of the first cave. Y The North end. Z The South end.
- YZ** The flat wall of rock, on the West side.
- B** The entrance into the great cavern, on the East side.
- EXQKVPI** The floor of the great cavern.
- Q** A little, narrow, irregular cave.
- D** The base of a column of stalactites, above 30 yards high.
- P** The base of the rock of more solid and round masses of stalactites.
- E** The great stone, which covers part of the mouth of
- F** A pit, or hole, two yards deep, lined with yellow stalactites like stucco.
- I** The base of a pile of encrusted stones, which lead up to a small cave.
- SK** The direction of the section fig. III.
- XV** The direction of the section of the great cavern, fig. IV.



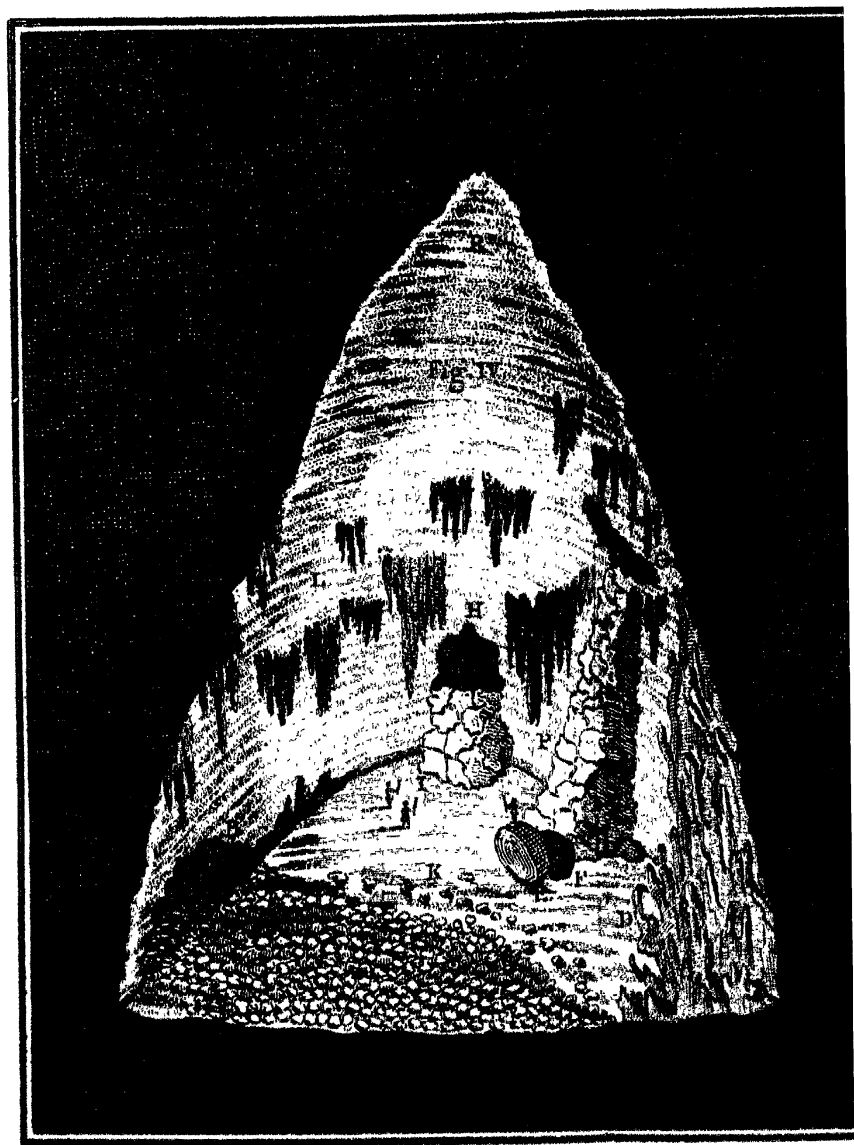


Fig. III.

- AC The shaft where I was let down.
- C The place where I began to swing, in the small cave.
- AS The perpendicular wall of rock on the West side.
- B The entrance into the great cavern on the East side.
- RT The great Vault or Dome.
- ST The heap of stones, which have been flung in from time to time.
- I Large drops of stalactites, in clusters.

Explanation of PLATE IX.

Fig. IV.

The inside of the great Cavern.

- B The entrance on the West side.
- K The continuation of the vast heap of stones.
- D The column of stalactites, above 30 yards high.
- E The great stone which covers part of the mouth of

F A

- F A pit or hole, two yards deep, lined with stalactites like stucco.
- P The rock of more solid and round masses of stalactites, on which I ascended about 20 yards.
- G A cleft in the rock at the top of the pile.
- I A pile of incrusted stones, which leads up to a small cave H.
- L Large drops of stalactites, hanging in large clusters.
- R The roof (probably somewhat of this form) but too high to be seen.

Fig. V.

A View of all the Caverns, with the second Shaft.

- WE The mouth of Elden Hole. W The West side. E The East.
- C The entrance into the lesser cave.
- B The passage into the great cavern.
- R The roof of the great cavern, reaching nearly to the surface of the ground.
- ST The slope formed by the heap of stones.
- SD The steep shelf of rock, probably, under it.
- D The mouth of the second shaft, which very probably still exists; but is covered up, somewhat in the manner here represented.

- F** The bottom of the second shaft.
- GH** A subterraneous river, at the bottom of the second shaft; which probably communicates with some of the rivers in that great cavern at Castleton: a circumstance there is reason to suspect, from hence, that those rivers, on great floods, are observed to cast up small fragments of a kind of grit stone, which grows plentifully in the parts of the country near Elden Hole; but is not to be found in the parts near the cavern at Castleton.

XXXII. *An Account of two new Tortoises;
in a Letter to Matthew Maty, M. D.
Sec. R. S.: By Thomas Pennant, Esq;
F. R. S.*

S I R,

Read May 2, ^{1771.} **I** BEG the favour of you to lay before the Royal Society, an account of two tortoises that have just fallen into my hands.

The first was communicated to me * by my worthy and learned correspondent Doctor Garden, of Charles Town, in South Carolina; a gentleman to whom the world is indebted for various information relating to the natural history of that province; and whose assiduity promises fair to enable me to make considerable additions to the accounts already given of the new world. He has favoured me with an ample description of this new animal; together with some relation of its manners; both of which are now delivered to the Society in the words of the ingenious writer.

* The specimen now under the inspection of the Society, was lent me, by my good friend Mr. Ellis; my own specimen being in the country: to Mr. Ellis I was also indebted for the elegant drawing of the animal, done from the life, in South Carolina.

“ I now come to speak of a species of Turtle or
 “ Tortoise, peculiar to our southern rivers. We call
 “ it the *soft shelled* Turtle; because, when alive, the
 “ covering looks like leather, very smooth and pliable,
 “ without any appearance of bone in it. It is
 “ very swift and fierce. They are not commonly
 “ got here in Charles-town, though by chance
 “ this last summer, I had two sent me. One of
 “ them I had preserved entire and sent to our friend
 “ Mr. Ellis; the other, less perfect, I have sent you.
 “ This is a very curious animal, and I think, a nondescript,
 “ for there is none of Linnæus’s fifteen
 “ species, that resemble it, except the first; and
 “ that, he particularly mentions, is found in the
 “ * Mediterranean; but this always inhabits fresh
 “ waters, remote from the sea. The head and snout
 “ are particularly distinguished from every other
 “ Turtle; and what is more, I am told they exceed
 “ any turtle in the delicacy of their taste and
 “ flavour. I never eat any of them; but have heard
 “ many speak of them who were great epicures, and
 “ they have assured me, that they were far preferable
 “ to the green kind.”

* There are two species of Tortoises in that sea, a coriaceous one, and another resembling that of the West Indies, which is scarce eatable. The last I procured from Leghorn, and at this time am doubtful whether it differs specifically from the West Indian Turtle.

Fresh Water Turtle, commonly called Soft Shelled Turtle. TAB. X.

“ THEY are found in large quantities in Savannah and Alatomaha rivers; and I have been told that they are very common in the rivers in East Florida.

“ They grow to very large sizes, though the largest that ever I heard of was seventy pounds.

“ The Turtle, which I now have by me, weighs twenty pounds; and probably, when I first got it, it might have weighed from twenty-five to thirty pounds, as I have observed that it has grown poorer every day. I have had it now near three months, and I never could observe that it has eaten any thing that has been given it, though a variety of things have been tried.

“ It is twenty inches long from one end of the shell or covering to the other, and fourteen inches and a half broad. The colour of this shell or covering, in general, is dark brown, with a greenish cast.

“ The middle part is hard, strong, and bony; but all round the sides, especially towards the tail and hindmost part, it is cartilaginous, soft and pliable, resembling thick tanned sole-leather, yielding very easily to any force in any direction whatever, but thick enough and strong enough to defend the animal from any injury. All the hind part of the back is full of oblong smooth knobs; and the fore part, just where it covers the head and neck, is studded full of large knobs. The under side of this plate is very beautiful,

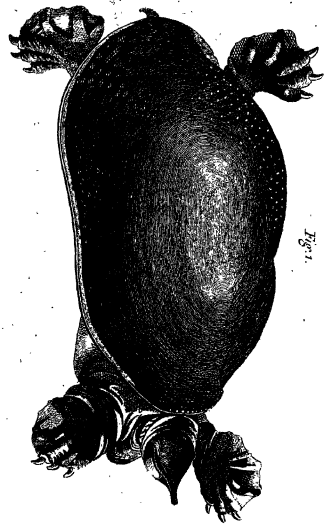


Fig. 1.



Fig. 4.



Fig. 2.



Fig. 3.

beautiful, of a lively whitish colour, interspersed with innumerable very fine ramifications of blood vessels, running from the margin of the plate into larger and larger branches, until the sight of them is at once lost by their entering the body of the animal.

“ The under, or belly plate, or rather *sternum*, is of a fair whitish colour, and extended forward two or three inches more than the back plate, so that the head rests on it very conveniently. The hind part of this plate is hard and bony, shaped very much like a man's riding saddle, with two pieces for the thighs to rest on. The fore part of the plate is pliable and cartilaginous.

“ The head is somewhat triangular and attenuated, rather apparently small for the animal, but growing gradually larger towards the neck, which is thick and long, and easily extended out (the neck of the present subject was thirteen inches and a half long) to a great length, or drawn back again under the shell or plate.

“ The eyes are placed in the fore and upper part of the head, near to one another, having pretty large loose palpebræ. The pupil is small and lively, surrounded by a lemon-coloured *iris*, perfectly round, and giving much life and fire to the eyes. When danger approaches, or when it goes to sleep, it covers its eyes, by bringing the inner and loose part of the lower *palpebræ* over its eye, like a *membrana nictitans*.

“ The upper lip and under lip are both large, but especially the upper. The *mandibula* are both entire, each being one entire bone all round, of the same shape as the mouth.

“ The

“ The nostrils are the most singular part, being a cartilaginous production of at least three quarters of an inch, beyond the upper and fore angle or point of the upper lip, perforated with two apertures reaching back and opening into the roof of its mouth, having a smooth *septum* but fimbriated upon each side. This, at first sight, in some manner resembles the snout of the mole ; but it is tender, thin and transparent, and cannot be intended for digging in the earth or land.

“ The arms are thick and strong, consisting of three distinct joints, *viz.* the upper, the fore arm, and hand. The hands have each five fingers, of which the three first are shorter and stronger, and furnished with strong nails, or rather claws. The two last fingers have more joints, but are smaller, and, instead of being furnished with claws, are covered with the membrane, which is extended even beyond their extremities. Towards the back or hind part, there are two spurious fingers, which just serve to support the membrane when extended. The upper side of these arms and hands are covered with a wrinkled loose skin, of a dusky greenish colour. The legs consist of the same number of joints, and have the same number of toes as there are fingers on the fore-feet, and these are furnished with nails in the same manner, only there is but one spurious toe. Both the fore and hind legs are thick, strong, and muscular ; and as the animal is very fierce, when it is attacked or disturbed, it often raises itself on its legs, and will leap forward to bite its disturber or enemy, which it does with great fury and violence.

“ They

“ They are likewise very strong, and of a lively whitish colour, because they are generally, if not always, covered with the upper plate, which, as I said before, is extended a great way behind.

“ The tail is large and thick, and generally as long as the hind part of the upper plate. The anus is placed about an inch from the extremity of the tail on the inside.

“ The Turtle, from which these characters were taken, was a female; after she came into my possession she laid fifteen eggs, and about the same number were taken out of the belly when she died. The eggs were nearly an inch diameter, and perfectly spherical.

“ It is esteemed very good eating, and said by many to be more delicate than the green turtle.”

The other Species of Tortoise, which I name

the Tuberculated,

was communicated to me by Mr. Humphries, of St. Martin's-Lane, merchant of minerals, shells, and insects. He was unacquainted with its place and history; therefore I must content myself with giving a meer description of it, deprived as I am of the knowledge of its manners and uses, without which even natural history is as replete with dulness as with inutility.

Its length, from nose to the extremity of the back, is three inches three lines; its greatest breadth, one inch and a half.

The head is large and scaly. The neck thick and wrinkled. Eyes full; nostrils small and oval; the end of the upper mandible long and bifurcated, lapping very far over the lower.

The back is divided length-ways, with five prominent ribs covered with large yellow tubercles, the intervening part is dusky and divided by multitudes of lesser and more depressed tubercles. The whole circumference of the back bounded by a tuberculated rib, like those on the upper part. The extremity furcated. The whole is coriaceous and pliant.

The tail is depressed sideways, tapers to a point, and reaches beyond the end of the back.

The belly is yellow, tuberculated like the back, but marked with six rows greatly prominent.

The prior fins are longer than the whole body, very thin, dusky, and edged on their interior sides with white, and both the surfaces are covered with depressed tubercles. The hind fins are broad, much dilated near their end, and slightly bilobated: none of these fins had the least marks of toes or nails.

This may probably be the same with the *Testudo coriacea* of *Linnaeus*, p. 350, or the coriaceous one above mentioned: but, as I have not at present before me the authors cited by that able naturalist, I will not pretend to pronounce with certainty whether it is the same.

Explanation of the Figures.

TAB. X.

- Fig. 1. The soft-shelled Tortoise.
 2. The same on its back.
 3. The same with its neck exerted; drawn from
 the dried animal.
 4. The tuberculated Tortoise.
 5. Exhibits the form of the mouth.

XXXIII. *Meteorological Observations at Caën in Normandy; for 1765, 1766, 1767, 1768, 1769. By Nathanael Pigott, Esq; communicated by the late Dr. Bevis, F. R. S.*

Read May 9, 1771.

1765.

Months	Days	Barometer.	Inches	Mean	Ther.	Mean	Remarks
January	31 9	Greatest height Least ditto	30,20 29,10	29.65			Wind chiefly S. S. W. 15th frost in the morning; the rest of the month was cloudy.
	8 31	Greatest ditto Least ditto			46.5 37.5	42	
February	24 28	Greatest ditto Least ditto	30,14 28,87	29,505			Wind chiefly N. and E. N. E. 4th frost and cloudy; 18th, 19th, 20th, 21st, 24th, 26th, small frost; 27th thaw; 28th rainy.
	27 19	Greatest ditto Least ditto			44.5 33.5	39	
March	8 23 1	Greatest ditto Least ditto	30,02 28,97	29,495			Wind chiefly S. S. W. 11th, 12th, 14th, 19th, 20th, 27th, 28th, high wind; 13th, 18th, 30th, 31st, stormy.
	24 1	Greatest ditto Least ditto			51,0 40,0	45.5	
April	12 20	Greatest ditto Least ditto	30,38 29,57	29,975			Wind variable; 1st stormy; 4th, 6th, 7th, 8th, 9th, 10th, 11th, 14th, 15th, 22d, high wind; sky almost always cloudy; 2d some fowls: 26th some thunder: fruit trees begin to bloom.
	27 28 13	Greatest ditto Least ditto			67.5 47.5	57.5	
May	12 15 24	Greatest ditto Least ditto	30,24 29,56	29,90			Wind mostly in the N. points: this month remarkable for fine sun, and clear sky.
	22 23 5	Greatest ditto Least ditto			67,0 53,0	60.0	
June	9 16 17	Greatest ditto Least ditto	30,22 29,78	30,00			Wind mostly in the North points: weather changeable the whole month: 3d some thunder and lightning with heavy rain at 4 P. M.
	4 5 29, 30	Greatest ditto Least ditto			70,0 61,0	65.5	

Month

Meteorological Observations, at Caën in Normandy.

1765.

Months	Days	Barometer	Inches	Mean	Ther.	Mean	Remarks
July	4	Greatest height	30,28	29 99			Wind most in the northern points; beginning, cloudy sky; middle, sun with clouds; end, windy and sun with flying clouds; 25th at 7h. P.M. therm. 77°.
	7	Least ditto	29,70				
	19 25 1	Greatest ditto Least ditto			72,0 52,0	67,0	
August	18	Greatest ditto	30,30	29,66 +			These observations are from the 10th to the 24th only. Wind variable; the beginning showery; 12th stormy; end, sunshine and clouds.
	22	Least ditto	29,03				
	23 12	Greatest ditto Least ditto			76,0 59,0	67,5	
November	21	Greatest ditto	30,27	29,645			Wind variable: beginning rainy; middle foggy; end, white frost in the mornings.
	25	Least ditto	29,02				
	1 23 24	Greatest ditto Least ditto			56,0 42,0	49,0	
December	16	Greatest ditto	30,34	29,73			Wind chiefly in the East points: beginning frosty: 5th hard frost; 8th, 9th, 10th, 11th, rain; remainder, almost constant frost.
	11	Least ditto	29,12				
	8 25	Greatest ditto Least ditto			51,0 37,0	44,0	

1766.

January	20	Greatest ditto	30,72	30,375			Wind chiefly E. S. E. from the beginning till the 20th, foggy and cloudy till the 20th; 31st, frost, 29th, 30th, 72 inches: height of barometer carefully set down.
	2 3	Least ditto	30,03				
	31 11	Greatest ditto Least ditto			40,0 17,0	33,5	
February	19	Greatest ditto	30,61	30,065			In the beginning wind in the North points; in the middle in the South; at the end to the Northern points; frost till 11th; wind and rainy till the end.
	17	Least ditto	29,52				
	15 8	Greatest ditto Least ditto			45,0 30,0	37,5	

Meteorological Observations at Caën in Normandy.

1766.

Month	Days	Barometer	Inches	Mean	Ther.	Mean	Remarks
March	7	Greatest height	30,29	29,565			Wind variable; 1st, 22d, stormy; 26th hurricane; 23d, 24th, 25th, wind and snow in the nights. The whole month mostly cloudy; from 25th to 26th, quicksilver fell in barometer 0,67 inches.
	26	Least ditto	28,84				
	13	Greatest ditto			53,0	46,5	
	13	Least ditto			40,0		
April	7	Greatest ditto	30,40	29,875			Wind variable; most part of the month rain and wind.
	24	Least ditto	29,35				
	27	Greatest ditto			57,0	52,5	
	1	Least ditto			48,0		
July	4	Greatest ditto	30,08	29,885			These observations from the 2d to the 16th only. Wind variable; cloudy and rainy.
	9	Least ditto	29,69				
	10	Greatest ditto			70,5	66,75	
	3	Least ditto			63,0		
August	26	Greatest ditto	30,27	30,065			Wind at beginning in the North points; middle variable; end in the South points. Clouds and wind almost the whole month.
	22	Least ditto	29,86				
	9	Greatest ditto			76,0	70,0	
	17	Least ditto			64,0		
September	17	Greatest ditto	30,38	29,99			Wind till towards the end varying; from the 25th S. S. E. Clouds and wind the whole month.
	7	Least ditto	29,60				
	27	Greatest ditto			72,0	66,0	
	16	Least ditto			60,0		
October	2	Greatest ditto	29,84	29,555			Wind mostly E. S. E. the end of the month variable; clouds and wind; 6th stormy; these observations from the 1st to the 10th only.
	8	Least ditto	29,27				
	5	Greatest ditto			70,0	66	
	9	Least ditto			62,0		

Mete-

Meteorological Observations, at Caën in Normandy.

1767.

Months	Days	Barometer	Inches	Mean	The.	Mean	Remarks
January	21	Greatest height	30,10	29,575			Wind mostly S. S. E. this month frosty; sometimes sharp and high winds.
	13	Least ditto	29,05				
	30	Greatest ditto			52,0	41,25	
	13	Least ditto			30,5		
February	1	Greatest ditto	30,03	29,665			Wind most in the South points. Rainy and windy from the 9th to the 15th. These observations only down to the 15th.
	8	Least ditto	29,30				
	1	Greatest ditto			54,0	52,0	
	10	Least ditto			50,0		
May	24	Greatest ditto	33,30	29,86			Wind varying the whole month. mostly rainy and windy.
	30	Least ditto	29,42				
	16	Greatest ditto			62,0	58,5	
	4	Least ditto			55,0		
June	10	Greatest ditto	30,15	29,77			Wind varying. 3d stormy; the whole month windy and rainy.
	3	Least ditto	29,39				
	29	Greatest ditto			65,5	60,25	
	3	Least ditto			55,0		
July	18	Greatest ditto	30,02	29,825			Wind varying. 21st stormy; from the 11th to the 30th cloudy and rainy. Few flies yet in the apartments, and these cannot fly.
	21	Least ditto	29,63				
	16	Greatest ditto			67,0	65,0	
	12	Least ditto			63,0		
September	13	Greatest ditto	30,16	29,89			These observations only from the 1st to the 15th; wind varying; weather changeable.
	4	Least ditto	29,62				
	4	Greatest ditto			72,0	68,0	
	15	Least ditto			64,0		

Mete-

Meteorological Observations at Caën in Normandy.

1767

Months	Days	Barometer	Inches	Mean	Thc.	Mean	Remarks
October	15	Greatest height	30.16	29.92			These observations from the 7th to the 20th only. Wind most in the North points, chiefly cloudy, some rain.
	8	Least ditto	29.68				
	8	Greatest ditto			62.0	57.5	
	14	Least ditto			53.0		
November	28	Greatest ditto	30.37	29.79			These observations from 14th to 29th only. Wind chiefly in the S. points; 18th, 21st, 22d, sun-shine and small frost; 16th the leaves still green on the trees.
	15	Least ditto	29.21				
	27	Greatest ditto			54.0	50.5	
	23	Least ditto			47.0		
December	3	Greatest ditto	30.44	29.815			23d began to freeze very hard with N. N. E. wind. See an account of this frost lower down. 1st, most trees have leaves, but yellow and begin to fall. 13th, the trees stripped of their leaves.
	20	Least ditto	29.19				
	8	Greatest ditto			54.0	43.5	
	27	Least ditto			33.0		

1768.

January	5	Greatest ditto	30.00	29.55			Wind mostly in the East points. 1st, much snow; high wind; hard frost to the 4th; 8th, thaws. The rest of the month rainy and windy.
	8	Least ditto	29.10				
	30	Greatest ditto			52.5	37.25	
	6	Least ditto			22.0		
February	6	Greatest ditto	30.37	29.965			In the beginning wind in the N. points; at the end in the S. This month mostly windy, cloudy and rainy.
	10	Least ditto	29.56				
	14	Greatest ditto			57.0	50.5	
	4	Least ditto			44.0		

Mete-

Meteorological Observations at Caën in Normandy.

1768

Months	Days	Barometer	Inches	Mean	The.	Mean	Remarks	
March	4 11	Greatest height	30.39	29.705			Wind chiefly E. towards the N. greatest part of this month frosty.	
	15	Least ditto	29.02					
	1 11	Greatest ditto			57.0	50.5		
	11 12	Least ditto			44.0			
April	11 29	Greatest ditto	30.16	29.795			Wind changing; 6th, storm of thunder, lightening, and hail, at 5 h. P.M. lightning fell on the church, called Abbaye aux Dames, ran over the choir with quick serpentine motion, and then disappeared without any further mischief; 29th, rain and thunder at 11 h. $\frac{1}{2}$ A. M.	
		Least ditto	29.43					
	17 1	Greatest ditto			61.0	56.0		
		Least ditto			51.0			
May	23 29	Greatest ditto	30.17	29.76			Wind chiefly in the N. points. This month was windy, and the sun shone with white broken clouds. 5th, at 10 h. P.M. storm of thunder, lightning and rain.	
		Least ditto	29.35					
	23 2 19	Greatest ditto			70.0	63.0		
		Least ditto			56.0			
June	21 26	Greatest ditto	30.16	29.855			Wind chiefly in the Westerly points. 7th, at 4 h. P.M. storm of hail thunder and lightning; from 9th to 22d, windy and rainy; 24th, stormy, with rain thunder and lightning.	
		Least ditto	29.55					
	24 20	Greatest ditto			69.0	65.8-		
		Least ditto			62.5			
July	21 7	Greatest ditto	30.14	29.845			Wind chiefly in the Westerly points. This month cloudy and windy, with some rain.	
		Least ditto	29.55					
	1 20	Greatest ditto			73.0	69.0		
		Least ditto			65.0			
August	9 4	Greatest ditto	30.13	30.015			These observations from the 3d to the 13th only. Wind most in the Western points; sky partly cloudy, partly clear.	
		Least ditto	29.96					
	12 9	Greatest ditto			70.0	68.0		
		Least ditto			66.0			

Mete-

Meteorological Observations at Caën in Normandy.

1768.

Months	Days	Barometer	Inches	Mean	The.	Mean	Remarks
September	14	Greatest height	30,03	29,74			These observations from the 7th to the 15th only. Wind unsettled, 12th, some thunder in the morning; the other days wind, clouds or rain.
	12	Least ditto	29,45				
	14	Greatest ditto			65,0	62,7+	
8	Least ditto			60,5			
October							October 30th, betwixt 12 h. and 13 h. at Harcourt, about 5 leagues S. W. of Caën, several gentlemen saw a ball of fire of a whitish colour, apparently of about a foot diameter, which cast a great light in the room, though the curtains were drawn, and there was a great fire and several wax lights in it: its direction from N. to S. It fell with great velocity, and seemingly about 30 or 40 yards from the room, without any explosion. I had just left the apartment, but was immediately informed of it; about 3 hours after, there was a violent hurricane of wind, hail and rain.
November	19	Greatest ditto	30,22	29,41			Barometer at noon the 21st 29,43
	23	Least ditto	28,60				ditto — — 22d 28,46
	15 30	Greatest ditto			54,0	49,0	fell in 24 hours 0,97
23	Least ditto			44,0	22d, continued rain; at 10½ P.M. smart flashes of lightning with thunder. Wind varying this month and the weather cloudy, rainy and windy; 15th leaves begin to fall.		
December	12	Greatest ditto	30,40	29,77			Wind chiefly in the Southern points. 2d storm of wind and rain; 14th hard frost. The weather this month unsettled.
	2	Least ditto	29,14				
	1	Greatest ditto			52,0	42,0	
15	Least ditto			32,0			

Mete-

Meteorological Observations, at Caën in Normandy.

1769.

Months	Days	Barometer	Inches	Mean	The.	Mean	Remarks
January	14 1	Greatest height Least ditto	30,16 29,49	29,825			Wind chiefly in the Southern points, cloudy, wind and rain; 24th white frost; 22d white frost: the weather this month unfetttled.
	13 22 24	Greatest ditto Least ditto			50,0 39,5	44,7 +	
February	20 5	Greatest ditto Least ditto	30,19 29,26	29,725			Wind mostly in the Eastern points. 4th at 12 h. P. M. hurricane, morning generally white frost. From the 22d to the end of the month, rainy, cloudy, and high wind.
	28 1	Greatest ditto Least ditto			53,0 39,0	46,0	
March	3 11	Greatest ditto Least ditto	30,47 29,20	29,835			Wind in the Northern and West points. All this month clouds and wind; little rain.
	4 10 31	Greatest ditto Least ditto			55,0 46,0	50,5	
April	24 8	Greatest ditto Least ditto	30,13 29,08	29,605			Wind at beginning in the North points; at the middle in the South points; at the end in the North points; 22d, white frost in the morning; the rest of the month chiefly rainy and windy.
	28 2.3.4.5.6	Greatest ditto Least ditto			62,5 46,0	54,2 +	
May	2 14	Greatest ditto Least ditto	30,39 29,50	29,945			Wind varying; 18th, at 3 h. P. M. thunder; 20th at 4 h. P. M. rain with thunder and lightning; 23d, at 11 h. P. M. thunder and lightning; 23d, at 3 h. P. M. ther. 75°; 27th, at 4 h. P. M. a very heavy rain. This month mostly windy and rainy.
	23 13	Greatest ditto Least ditto			73,0 54,0	63,5	
June	11 15	Greatest ditto Least ditto	30,19 29,65	29,92			These observations from 2d to the 19th only; wind chiefly in the W. points. This month cloudy, windy and rainy.
	9.10.13 15	Greatest ditto Least ditto			65,0 61,0	63,0	

Meteorological Observations at Caën in Normandy.

1769.

Month	Days	Barometer	Inches	Mean	Ther.	Mean	Remarks
July	10 8	Greatest height Least ditto	30,16 29,04	29,60			These observations from 6th to 16th only; wind variable; first days clouds; the last days clear sun.
	7 10.	Greatest ditto Least ditto			76,0 69,0	72,5	
August	18 22	Greatest ditto Least ditto	30,12 29,50	29,81			These observations from the 14th to the 23d only. Wind chiefly in the West points; clouds and wind.
	15 21	Greatest ditto Least ditto			70,0 63,5	66,7+	
September	16 12	Greatest ditto Least ditto	30,17 29,40	29,785			Shifting winds; 9th, at 3h. P. M. a very heavy shower of hail from the W. the hailstones about the size of a middling walnut, of different irregular shapes; the largest of some, brought to me after the storm, diminished in volume, and weighed still a penny-weights and 2 grains; the storm lasted about 2 or 3 minutes.
	6 19 26	Greatest ditto Least ditto			71,0 60,0	65,5	
October	10 22	Greatest ditto Least ditto	30,30 29,66	29,98			Wind variable; weather unsettled; often changing.
	19 20 7	Greatest ditto Least ditto			63,0 48,6	55,8	
November	28 22 23	Greatest ditto Least ditto	30,52 29,55	30,035			These observations from 18th to 30th only; wind shifting; 19th, 20th, hard frost; the rest of the month mostly wind with some rain.
	27 20	Greatest ditto Least ditto			55,0 40,0	47,5	
December	4 23	Greatest ditto Least ditto	30,38 28,69	29,59			These observations from the 3d to 24th only; the wind almost always in the South points; wind and rain; 23d, squalls at 8h. P. M. the barometer being at 28,69 inches.
	23 8	Greatest ditto Least ditto			55,0 43,0	49,0	

Mete-

Meteorological Observations at Caën in Normandy.

Inches 1765	Mean height of Barometer	Inches	Mean height of Barometer.	Remarks
29,650	January	29,550	January 1768	These observations were made at noon, in a South-West room, with a barometer, whose tube is about $\frac{1}{8}$ of an inch diameter; in which the motion of the quicksilver, in squalls and gusts of wind, is extremely perceptible; yet, for further satisfaction, I ordered another to be made in London, with the greatest care, by Heath and Wing, with a nonius giving the $\frac{1}{100}$ part of an inch. I placed this barometer by the other, in July 1769; and having compared them every day for a year, I find that the ancient one marks $\frac{1}{100}$ of an inch more than the other; therefore, if from the mean height as above — 29,802 be deduced — 0,050 the true mean height is 29,752
29,505	February	29,605	February	
29,495	March	29,705	March	
29,975	April	29,795	April	
29,900	May	29,760	May	
30,000	June	29,855	June	
29,990	July	29,845	July	
29,66+	August	30,015	August	
	September	29,740	September	
29,645	November	29,410	November	
29,730	December	29,770	December	
29,655	mean of these means	29,828+	mean of these means	
30,375	January 1766	29,825	January 1769	The greatest height observed, at noon, was, Jan. 29, 1766, 30,72 The least, Dec. 23, 1769, at 8 h. P. M. —
30,065	February	29,725	February	
29,565	March	29,835	March	
29,875	April	29,605	April	
29,885	July	29,915	May	
30,065	August	29,920	June	
29,990	September	29,600	July	
29,555	October	29,810	August	
		29,785	September	
29,992—	mean of these means	29,98	October	
		30,035	November	
29,575	January 1767	29,590	December	
29,665	February			Limits of the motion of quicksilver — 2,03
29,860	May	29,805	mean of these means	
29,770	June			
29,825	July	Mean height	In the years	
29,890	September			
29,920	October	29,665	1756	
29,790	November	29,922	1766	
29,815	December	29,790	1767	
		29,828+	1768	
		29,835	1769	
29,790	mean of these means			
		29,802	mean of these means	

Hence it appears, that if the mean height of barometers, on a level with the surface of the sea, be supposed, with Dr. Scheuchzer, Phil. Trans. N^o 405, 406, — 29,993 inches and the mean height at Caën, — — 29,752 ditto

0,241 the diff.

will be the greater mean weight of the atmosphere at the surface of the sea, then at Caën : and if, with the Doctor, we allow, for each tenth of an inch depression of the quicksilver, 90 feet elevation, my room, which is in the highest part of the town, will be about 217 feet above the level of the sea.

Monsieur de Luc, of Geneva, has given a method to measure the different elevation of places by barometers, grounded on his own observations, far more exact than any other before him ; his rule is, “ the difference of the logarithms of the height of “ the quicksilver, in the two places, reduced into French lines, “ and the logarithms carried to five places, including the characteristics, will give the difference of elevation in toises, if “ Fahrenheit’s thermometer be nearly at 66° ; but about $\frac{1}{8}$ must “ be deducted from the elevation so given, if the thermometer “ be at 55° or temperate.”

29,993 English inch. = 337,824 French lines log. 25286,8
29,752 ditto = 335,110 ditto log. 25251,9

diff. 34,9 toises

or 209 4 French feet = 223 English feet nearly ; from which if $\frac{1}{8} = 12 \frac{1}{2}$ nearly be deducted, 210 $\frac{1}{2}$ feet remain for the difference of elevation of my room and the surface of the sea, which differs 6 $\frac{1}{2}$ feet from the result given by the first hypothesis.

The greatest height observed, in these five years, with a good Fahrenheit’s thermometer screened from the sun, in a S. W. room, was as follows at noon :

1765 August 23d }
1766 August 9th } 76°
1765 June 7th }

the least height of ditto Jan. 6th 1768 — — 14

1765 August 23, exposed the thermometer, at noon, to the sun, suspended on a thread between two sticks, in the middle of my garden at Caën, which may be about two English acres, so that the thermometer received the least reflected heat possible in that place ; the quicksilver stood as follows,

[285]

at 1^h P.M. 97°

at 2 ditto 96

1765 August 26, at a village, called *les Iles Bardelles*, 7 leagues from Caen, the same thermometer, in a South room, from which the sun was excluded by the window shutters, rose to 90°.

An Account of a remarkable degree of cold observed at Caën in Normandy.

1767	Ther.	Hours	Barometer
December	°	h /	Inch.
24	+ 12	at 8 0	30,02
	+ 16	at 9 0	30,02
25	+ 18	at 11 0	29,9 { little wind at E. S. E. small fog. cloudy.
	+ 15	at 12 44	
	+ 18	at 21 45	
		at 22 00	
26	+ 15	at 10 00	29,67 wind N. E.
	+ 11	at 19 00	
	+ 12	at 21 00	
		at 22 00	
27	+ 17	at 7 00	29,49 no wind.
	+ 16½	at 8 00	
	+ 12	at 10 00	
	+ 11	at 11 00	
	+ 10	at 18 00	
	+ 10	at 20 00	
28		at 22 00	29,46 { little wind S.S. E. flying clouds.
	+ 15	at 8 20	
	+ 14	at 11 00	
	+ 13	at 19 00	
30	+ 18	at 22 00	29,84 little wind S. flying clouds
	+ 23	at 7 00	
	+ 20	at 10 00	
	+ 11	at 19 00	
	+ 14	at 21 00	An
		at 22 00	

An Account of a remarkable degree of cold, observed at Caën in Normandy.

1768	Ther.	Hours	Barometer.
January	o	h /	
3	+ 10	at 11 00	
	+ 9	at 20 00	
	+ 11	at 5 00	
	+ 10	at 6 00	
	+ 8	at 8 00	
4	+ 6	at 9 15	
	0	at 12	
	— 8	at 19 30	
	0	at 21 0	30,03 clear sky, no wind.
		at 19 0	30,00 wind W. by S.
	— 2½	at 5 30	
	— 2	at 6 30	
	— 2	at 8 00	
	+ 1	at 9	
	0	at 9 30	
	— 3	at 10 00	
5	0	at 10 35	
	0	at 11 00	
	+ 3	at 19 30	
	+ 6	at 20 00	
	+ 7	at 21 00	
	+ 8	at 21 30	
	+ 10	at 22 15	
	+ 14	at noon	
6	+ 12	at 7 15	
	+ 14	at 8 45	
	+ 13	at 10 00	

N. B. The sign + signifies, that the degrees marked by the quick-silver were above 0, or the beginning of the division.
The negative sign — signifies, that the degrees were below 0, or the beginning of the divisions.
The thermometer was exposed in the open air to the North.
The hours are astronomical hours.

Experi-

Experiments on some Liquids.

1768	H. M.	
Jan. 3	11 30	I placed a wine glass half full of rack, another half full of rum, in a North window, to the open air: the next day, at the same hour, the rack was frozen to a thick jelly, with icy particles; the rum also to a jelly, but less thick.
	4 50	I exposed, as above, a wine glass, half full of cyder: ditto of beer.
	5 13	Ditto of red wine, called Beaujenci.
	6 30	The cyder began to freeze.
		Ditto consolidated.
4	5 5	The beer began to freeze.
	6 30	Ditto consolidated.
	5 12	The wine began to freeze.
	6 30	Ditto nearly consolidated.
	.	The icy surface of the cyder being broken, it froze over again, in three or four seconds, the ice forming, with a progressive motion, very perceptible to the eye.
	9 00	I exposed, as above, a wine glass half full of Malaga wine.
		Half ditto of Burgundy, called Migraine.
		Half ditto of Rouffillon wine.
		Half ditto of spring water.
		Half ditto of cyder-brandry.
5	9 15	The water began to freeze.
	9 30	Ditto consolidated.
	9 30	The Malaga, Migraine, Rouffillon, began to freeze.
	11 00	Ditto ditto ditto consolidated.

N.B. The brandy did not freeze; but the 6th at noon, the quantity was diminished, and some icy particles stuck to the glass, above the surface of what remained. I found, by weighing the above liquids hydrostatically, in a temperate state of heat, that the migraine, cyder, beaujenci, boer, and the water, were very nearly of the same specific gravity; and that a piece of gold, which

weighed in the water	-	-	224,25 grains,
weighed in the Malaga	-	-	224,00 ditto,
in the Rouffillon	-	-	224,50 ditto,
in the brandy	-	-	225,00 ditto.

XXXIII. *Nyctanthes elongata, nova Planta Indica, quam, descriptione atque icone illustratam, illustrissimæ Societati Regiæ Londinensi reverenter offert Petrus Jonas Bergius, M. D. Succus, R. Soc. Lond. aliarumque Societ. Membr.*

Read May 9, 1771. **E**TSI Botanicis plantarum in India orientali nascentium multa dudum messis fuit, tamen non dubitandum arbitror, quin adhuc satis amplius variis locus detur spicilegiis. Loquor jam potissimum de oris oceano vicinis, quæ plantarum curiosis identidem patuerunt; non de regionibus istius terræ ab oceano remotioribus, utpote quæ, a nullo botanico in hunc usque diem calcatæ, adeo non novarum minusve cognitarum plantarum offerrent spicilegia, si cuiquam oculatori contingeret eas adire, ut potius integram atque abundantem earundem sine dubio præberent messem. Ut autem harum regionum gaza herbaria admodum foret exoptanda summoque nisu desideranda, ita nec illarum exilior forte jam residua supellex ullatenus est contemnenda, quin potius attentis, quoad liceat, oculis considerata ab unoquoque, qui contemplatione naturæ, uti par est, delectatur.

Ego proinde cupide ac libenter excepi oblatas ~~multas~~ aliquoties ab amicis, ex itinere Chinensi reversis, haud paucas stirpes, in diversis oceani Indici insulis
 Vol. LXI. P p deprehenſas;

deprehensas; quas ubi studiosius contemplor, video-euq nonnullas raritate præstantissimas, atque idcirco novas, quod Botanicorum antea innotuerunt nemini, congruens meis puto studiis eas omnes impense examinare apteque describere & delineare. Cæterum ne hæcce res justo diutius duci per alias meas occupationes videatur, occasionem sectabor quam potero primam delicias hæc cum orbe erudito communicandi.

Patiatur itaque illustrissima Societas Regia Londinensis, quod ad acta ipsius nunc illico transmittam exactissimam iconem idoneamque descriptionem novæ cujusdam plantæ Indicæ, quam ad Nyctantis genus amandare debui, etiamsi illius habitus satis abludit a cunctis dudum cognitis Nyctanthis speciebus. Una quidem harum, nempe Nyctanthes multiflora, a Cl. N. L. Burmanno, *Flor. Ind. tab. III. fig. 1.* delineata, quodammodo cum mea convenit ipso florum situ; sed tamen valde ab ea discrepat, non solum florum magnitudine, sed etiam foliorum figura & reliquo habitu, unde quoque diversitas satis elucet specierum.

Icon adjuncta (TAB. XI.) ramulum refert naturali magnitudine expictum; & vero ramulum ipsum accepi ab amico C. G. Ekeberg, ex itinere in Chinam domum non ita pridem feliciter redeunte.

NYCTANTHES (*elongata*) foliis cordato-lanceolatis acutis elongatis minoribusque, ramis teretibus.

DESCR. *Caulis* fruticosus. *Rami* subprocumbentes, oppositi, teretes, inferiores glabri, superiores villosi, ramosi: ramulis oppositis. *Folia* opposita, cordato-lanceolata, subbipollicaria, acuminata, integerrima, utrinque glabra, nervosa, margine paululum undulata, saturate viridia; inferiora ramulorum sensim minora,

minora, infima vero cordato-ovata, parva. *Flores* in ramulis terminales, 5 vel 6 congesti, subumbellati, breviter pedicellati. *CALYCIS* perianthium monophyllum, tubulatum, minimum, persistens, sex vel septemfidum : laciniis subulatis, pilosis. *COROLLA* monopetala ; *Tubus* cylindricus, striatus, longus, pollicaris, superne incrassatus ; *Limbus* planus, octo vel novempartitus : laciniis ovato-oblongis, acutis. *STAMINA*, *Filamenta* bina, brevia ; *Antheræ* lineares, obtusæ, utrinque sulcatæ, intra tubum corollæ occultatæ. *PISTILLUM*. *Germen* subrotundum, truncatum, retusum, glabrum. *Stylus* filiformis longitudine staminum. *Stigma* incrassatum, bifidum.

XXXIV. *Account of a Mole from North America: In a Letter to Dr. Maty, Sec. R. S. from the Hon. Daines Barrington, F. R. S.*

DEAR SIR,

May 15, 1771

Read May 15, 1771. **I** Send herewith a mole from North America, which Mr. Kuckahn (who hath before presented several birds and insects to the Society) desires they will do him the honour to place in their Museum:

This species of mole much resembles that of Europe in its general appearance, except in point of colour: to shew, however, that there is a very material and specific difference between the two animals, I have inclosed the head of the common English mole, which contains all the teeth belonging to each jaw.

The American specimen is not indeed so perfect in this respect; but a sufficient number of teeth remains, to shew the distinction between these two sorts of moles.

In the European, you will observe six cutting teeth in the upper jaw, which are followed by two canine ones.

In the American (on the other hand) there are two very long and large cutting teeth in the centre, calculated to fill the vacancy in the lower jaw, which contains only two short cutting teeth, followed immediately by two long canine ones.

In the lower jaw of the European mole, however, there are eight small cutting, without the intervention of any canine teeth. I am,

Dear Sir,

Your most faithful

humble servant,

Daines Barrington.

XXXV. *Letter from the Hon. Daines Barrington, F. R. S. to William Heberden, M. D. F. R. S. giving an Account of some Experiments made in North Wales, to ascertain the different Quantities of Rain, which fell in the same Time, at different Heights.*

S I R,

December 24, 1770.

Read June 6,
1771.

AS I happened to be at the meeting of the Royal Society, when your experiments were read, relative to the different quantities of rain, which fell within receivers of the same dimensions at different heights from the ground; it occurred to me, that the same trials might be made at more disproportionate heights, though at the same distance from the surface of the earth.

I accordingly directed two rain-gages of exactly the same dimensions to be made by your instrument-maker, which you was so obliging as to take the trouble of examining.

As I proposed to keep them at the top and bottom of a Welch mountain, and am not stationary a sufficient time in the Principality to attend to a long course of such observations; I sent the rain-gages to
Mr.

Mr. Meredith Hughes, of Bala, in Merionethshire, who is a very ingenious land-surveyor, and, from his philosophical turn, would be pleased with executing the commission, though a very troublesome one.

I directed him to place one of the rain-gages at the top of Rennig, which is about four miles West of Bala, and is commonly considered as the fifth mountain of North Wales, in point of height*.

I directed the other rain-gage to be fixed near a house, called Bochrhaidr, at about half a mile's distance from Rennig; and so as that the rain might not be impeded, when the wind blew over the mountain towards the point where the lower rain-gage was placed. Proper precautions were also taken, that neither cattle, nor any other accident, should interfere with the experiment.

Being desirous to know with some degree of precision the height of this mountain, I directed Mr. Hughes to ascertain it in the common method, by examining the fall of the mercury in the barometer, at the top, when compared with its state at the bottom. Having made this experiment, he informed me, that the difference was one inch and sixteenths, which according to Dr. Halley's method of computation, would give about 450 yards in height, from the adjacent plain.

By the following table it will appear, that the quantities of rain, which had fallen in the two rain-

* I rather suppose it, however, to be only the sixth, and should range them thus, according to their comparative heights: Carnedd Llewelin, Snowdon, Cader Idris, Arran Mowddu, Glider, and Rennig. I place Carnedd Llewelin before Snowdon, because I carried a water level to the top of the latter, and conceived Carnedd Llewelin to be higher; perhaps the difference may be only a few yards.

gages were weighed six several times; in three of which the contents of the upper receiver exceeded those of the lower; and in the three others, the quantity in the lower exceeded that of the upper. On the whole, however, the contents of the lower rain-gage exceeded that of the upper above half an inch. This trifling difference therefore seems to arise from a shower's lasting perhaps a little longer on the bottom of the mountain, and not from any permanent cause, as in your observations.

I am persuaded, that these experiments have been made with the greatest attention and accuracy, as I was at Bala in August last, and found that all my directions had been most punctually followed.

The inference to be drawn however from them (such as they are) seems to be, that the increase of the quantity of rain depends upon its nearer approximation to the earth, and scarcely at all upon the comparative height of places, provided the rain-gages are fixed at about the same distance from the ground.

Possibly also a much controverted point between the inhabitants of mountains and plains may receive a solution from these experiments; as in an *adjacent valley, at least*, very nearly the same quantity of rain appears to fall within the same period of time as upon the neighbouring mountains. I am, Sir,

Your most faithful

humble servant,

Daines Barrington.

1770.	Bochyraidr.		The top of Rennig.	
	Grains	Inches.	Grains.	Inches.
From July 6th to 16th	5080	= 0,709	4643	= 0,648
July 16th to 29th	15654	= 2,185	15217	= 2,124
July 29th to Aug. 10th	4370	= 0,610	4698	= 0,656
Sept. 9th both bottles had run over.				
Sept. 9th to 30th	23167	= 3,234	17648	= 2,464
Oct. 17th both bottles had run over.				
Oct. 17th to 22d	5353	= 0,747	6336	= 0,885
Oct. 22d to 29th	9179	= 1,281	9944	= 1,388
Nov. 20, both bottles were broken by the frost.				
		8,766		8,165

N O T E.

It may not be improper to subjoin to the foregoing account, that, in the places where it was first observed, that a different quantity of rain would be collected, according, as the rain-gages were placed above or below the tops of the neighbouring buildings, the rain-gage below the top of the house, into which the greater quantity of rain had for several years been found to fall, was above fifteen feet above the level of the other rain-gage, which in another part of London was placed above the top of the house, and into which the lesser quantity always fell. This difference therefore does not, as Mr. Barrington justly remarks, depend upon the greater quantity of atmosphere, through which the rain descends; though this has been supposed by some, who have thence concluded, that this appearance might readily be solved by the accumulation of more drops, in a descent through a greater depth of atmosphere. W. H.

XXXVI. *A Disquisition concerning certain Fluents, which are assignable by the Arcs of the Conic Sections ; wherein are investigated some new and useful Theorems for computing such Fluents : By John Landen, F. R. S.*

Read June 6,
1771.

MR. Mac Laurin, in his Treatise of Fluxions, has given sundry very elegant Theorems for computing the Fluents of certain Fluxions by means of Elliptic and Hyperbolic Arcs ; and Mr. D'Alembert, in the Memoirs of the Berlin Academy, has made some improvement upon what had been before written on that subject, But some of the Theorems given by those Gentlemen being in part expressed by the difference between an Arc of an Hyperbola and its Tangent, and such difference being not directly attainable, when such Arc and its Tangent both become infinite, as they will do when the *whole* Fluent is wanted, although such Fluent be at the same time finite ; those Theorems therefore in that case fail, a computation thereby being then impracticable, without some farther help.

The supplying that defect I considered as a point of some importance in Geometry, and therefore I

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Fig. 1.

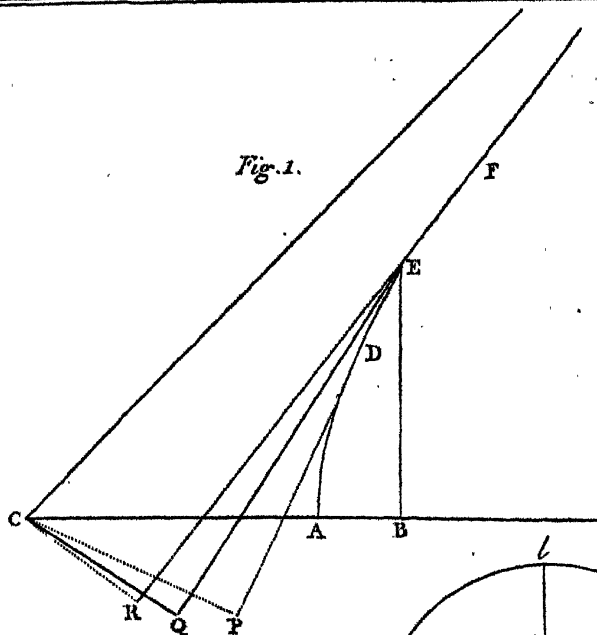


Fig. 2.

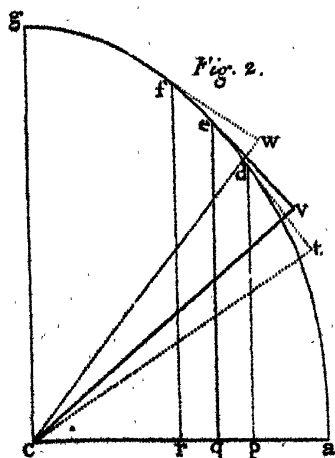
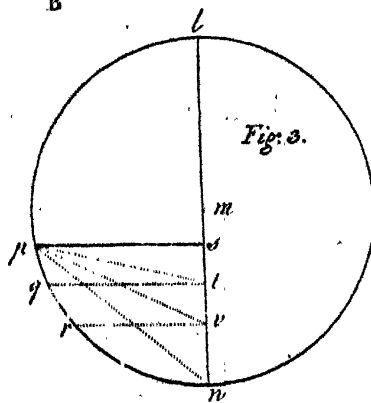


Fig. 3.



earnestly wished, and endeavoured, to accomplish that business; my aim being to ascertain, by means of such arcs, as above-mentioned, the *Limit* of the difference between the Hyperbolic Arc and its Tangent, whilst the point of contact is supposed to be carried to an infinite distance from the vertex of the curve, seeing that, by the help of that *Limit*, the computation would be rendered practicable in the case wherein, without such help, the before-mentioned Theorems fail. And having succeeded to my satisfaction, I presume, the result of my endeavours, which this Paper contains, will not be unacceptable to the Royal Society.

1.

Suppose the curve ADEF (Tab. XII. fig. 1.) to be a conic *Hyperbola*, whose semi-transverse axis AC is $= m$, and semi-conjugate $= n$.

Let CP, perpendicular to the tangent DP, be called p ; and put $f = \frac{m^2 - n^2}{2m}$, $x = \frac{p^2}{m}$. Then (as is well known) will DP ~~be~~ AD be $=$ the fluent of $\frac{\frac{1}{2} m^{\frac{3}{2}} x^{\frac{3}{2}}}{\sqrt{n^2 + 2fx - x^2}}$, p and x being each $=$ to m when AD is $= v$.

2.

Suppose the curve adefg (fig. 2.) to be a quadrant of an *Ellipsis*, whose semi-transverse axis cg is $= \sqrt{m^2 + n^2}$, and semi-conjugate ac $= n$. Let

Q q 2

ct

ct be perpendicular to the tangent dt, and let the abscissa cp be $= n \times \frac{z}{m}^{\frac{1}{2}}$. Then will the said tangent dt be $= m \times \frac{mz - z'}{n^2 + mz}^{\frac{1}{2}}$; and the fluxion thereof will be found

$$= \frac{1}{2} mn^2 z^{-\frac{1}{2}} \dot{z} \times \frac{m - z'}{n^2 + mz}^{\frac{1}{2}} - \frac{\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}} \dot{z}}{\sqrt{n^2 + 2fz - z'^2}}$$

3.

In the expression $\frac{y q^{-r} \dot{y}}{a + by}^r \times c + dy$, let $\frac{c + dy}{a + by}$ be supposed $= z$. Then will $\frac{az - c}{d - bz}$ be $= y$, and the proposed expression will be

$$= \frac{\overline{ad - bd}^{1-r-s} \times z^{-r} \dot{z}}{az - c^{1-r} \times d - bz^{1+q-r-s}}$$

4.

Taking, in the last article, r and s each $= \frac{1}{2}$, $q = \frac{3}{2}$, $a = -d = \frac{n^2}{m}$, $b = 1$, and $c = n^2$, we have

$$\frac{y^{\frac{1}{2}} \dot{y}}{\left(\frac{n^2}{m} + y \right)^{\frac{1}{2}} \times n^2 - \frac{n^2}{m} y}^{\frac{1}{2}} \left(= \frac{m^{\frac{1}{2}} n^{-1} y^{\frac{1}{2}} \dot{y}}{\sqrt{n^2 + 2fy - y^2}} \right)$$

$$= -mnz^{-\frac{1}{2}} \dot{z} \times \frac{m - z'}{n^2 + mz}^{\frac{1}{2}}$$

It

It appears therefore, that, y being $= n^2 \times \frac{m-z}{n^2+mz}$,

$$-\frac{\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}} y}{\sqrt{n^2 + 2fy - y^2}} = -\frac{\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}}}{\sqrt{n^2 + 2f}} \text{ is}$$

$$\frac{1}{2} m n^2 z^{-\frac{1}{2}} z \times \frac{\frac{m-z}{n^2+mz}^{\frac{1}{2}}}{\sqrt{n^2 + 2f}} = \frac{\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}}}{\sqrt{n^2 + 2fy - y^2}},$$

which, by Art. 2. is = the *fluxion of the tang.* d t.

Consequently, taking the fluents, by Art. 1. and correcting them properly, we find

$$DP - AD + FR - AF = L + d t.$$

$$CP, \text{ in fig. 1. being } = m^{\frac{1}{2}} z^{\frac{1}{2}}; \text{ cp, in fig. 2. } = n \times \frac{z}{m}^{\frac{1}{2}};$$

$$CR, \text{ perpendicular to the tangent } FR = m^{\frac{1}{2}} y^{\frac{1}{2}};$$

$$DP - AD = \text{the fluent of } \frac{-\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}} z}{\sqrt{n^2 + 2fy - y^2}};$$

$$FR - AF = \text{the fluent of } \frac{-\frac{1}{2} m^{\frac{1}{2}} y^{\frac{1}{2}} y}{\sqrt{n^2 + 2fy - y^2}};$$

and L the *Limit* to which the difference $DP - AD$, or $FR - AF$, approaches, upon carrying the point D , or F , from the vertex A *ad infinitum*.

5.

Suppose y equal to z , and that the points D and F then coincide in E , the points d and p being at the same time in e and q respectively. Then cv being perpendicular to the tangent ev , that tangent will be a *maximum* and equal to $cg - ac = \sqrt{m^2 + n^2} - n$; the tangent EQ (in the hyperbola) will be $= \sqrt{m^2 + n^2}$;
the

the abscissa $BC = m \sqrt{1 + \frac{n}{\sqrt{m^2 + n^2}}}$; the ordinate

$BE = n \times \sqrt{\frac{n}{\sqrt{m^2 + n^2}}}$; and it appears, that

L is $= 2EQ - 2AE - cy = n + \sqrt{m^2 + n^2} - 2AE$!
Thus the *Limit* which I proposed to ascertain is investigated, m and n being any right lines whatever!

6.

The whole fluent of $\frac{\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}} z}{\sqrt{n^2 + 2fx - x^2}}$, generated whilst z from o becomes $= m$, being equal to L ; and the fluent of the same fluxion (supposing it to begin when z begins) being in general equal to $L + AD - DP = FR - AF - dt$; it appears, that, k being the value of z corresponding to the fluent $L + AD - DP$, $\frac{mn^2 - n^2 k}{n^2 + mk}$ will be the value of z corresponding to the fluent $L + AF - FR$, and $FR - AF$ will be the part generated whilst z from $\frac{mn^2 - n^2 k}{n^2 + mk}$ becomes $= m$. It follows therefore, that the tang. dt , together with the fluent of $\frac{\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}} z}{\sqrt{n^2 + 2fx - x^2}}$ generated whilst z from o becomes equal to any quantity k , is equal to the fluent of the same fluxion generated whilst z from $\frac{mn^2 - n^2 k}{n^2 + mk}$ becomes $= m$; o being taken $= n \times \frac{n}{m}$.

Suppose

Suppose $k = \frac{m n^2 - n^2 k}{n^2 + m k}$, its value will then be $\frac{n}{m} \sqrt{m^2 + n^2} - \frac{n^2}{m}$. Consequently the fluent of

$\frac{\frac{1}{2} m^{\frac{1}{2}} x^{\frac{1}{2}} \dot{x}}{\sqrt{n^2 + 2fx - x^2}}$ generated whilst x from o becomes $= \frac{n}{m} \sqrt{m^2 + n^2} - \frac{n^2}{m}$, together with the quantity $\sqrt{m^2 + n^2} - n$, is equal to the fluent of the same fluxion generated whilst x from $\frac{n}{m} \sqrt{m^2 + n^2} - \frac{n^2}{m}$ becomes $= m$: and these two parts of the *whole fluent* being denoted by M and N respectively; M will be $= n - AE$, and $N = \sqrt{m^2 + n^2} - AE$.

7.

The fluent of $\frac{\frac{1}{2} m^{\frac{1}{2}} x^{\frac{1}{2}} \dot{x}}{\sqrt{n^2 + 2fx - x^2}}$ being $L + AD - DP$, the fluent of $\frac{\frac{1}{2} m^{\frac{1}{2}} x^{\frac{1}{2}} \dot{x}}{\sqrt{n^2 + 2fx - x^2}} + DP - AD - L$ will be $= o$.

Therefore, the fluent of $\frac{\frac{1}{2} m^{\frac{1}{2}} x^{\frac{1}{2}} \dot{x}}{\sqrt{n^2 + 2fx - x^2}}$ + the fluent of $\frac{\frac{1}{2} m^{-\frac{1}{2}} n^2 x^{-\frac{1}{2}} \dot{x}}{\sqrt{n^2 + 2fx - x^2}}$ being $=$ the fluent of $\frac{1}{2} x^{-\frac{1}{2}} \dot{x} \times \frac{n^2 + mx}{m - x}^{\frac{1}{2}}$,

it is obvious, that the fluent of $\frac{\frac{1}{2} m^{-\frac{1}{2}} n^2 x^{-\frac{1}{2}} \dot{x}}{\sqrt{n^2 + 2fx - x^2}}$ is $= DP - AD - L +$ the fluent of $\frac{1}{2} x^{-\frac{1}{2}} \dot{x} \times \frac{n^2 + mx}{m - x}^{\frac{1}{2}} = DP$

= DP — AD — L + the *elliptic arc* dg (fig. 2.)

whose abscissa cp is = $n \times \frac{\sqrt{m^2 + n^2}}{m}$.

Consequently, putting $\frac{1}{2}$ for $\frac{1}{4}$ of the periphery of that ellipsis, it appears that the *whole fluent* of

$\frac{\frac{1}{2} m^{-\frac{1}{2}} n^2 z^{-\frac{1}{2}} \dot{z}}{\sqrt{n^2 + 2fz - z^2}}$, generated whilst z from o becomes $=m$, is equal to $E - L = E + 2AE - n - \sqrt{m^2 + n^2}$.

8.

By taking, in Art. 3. q, r , and s , each = $\frac{1}{2}$; and $a = -d = \frac{n^2}{m}$, $b = 1$, and $c = n^2$; we find,

that, if y be = $\frac{mn^2 - n^2 z}{n^2 + mz}$, $\frac{z^{-\frac{1}{2}} \dot{z}}{\sqrt{n^2 + 2fz - z^2}} + \frac{y^{-\frac{1}{2}} \dot{y}}{\sqrt{n^2 + 2fy - y^2}}$ will be = 0.

It is obvious therefore, that the fluent of $\frac{z^{-\frac{1}{2}} \dot{z}}{\sqrt{n^2 + 2fz - z^2}}$, generated whilst z from o becomes equal to any quantity k , is equal to the fluent of the same fluxion, generated whilst z from $\frac{mn^2 - n^2 k}{n^2 + mk}$ becomes = m .

Now, supposing $k = \frac{mn^2 - n^2 k}{n^2 + mk}$, its value will be $\frac{n}{m} \sqrt{m^2 + n^2} - \frac{n^2}{m}$.

Consequently, the fluent of $\frac{z^{-\frac{1}{2}} \dot{z}}{\sqrt{n^2 + 2fz - z^2}}$, generated whilst z from o becomes = $\frac{n}{m} \sqrt{m^2 + n^2} - \frac{n^2}{m}$,
is

is equal to *half* the fluent of the same fluxion, generated whilst x from o becomes $= m$; which *half fluent* is known by the preceding article.

9.

It appears, by Ar. 4. that

$$\frac{\frac{1}{2} m^{\frac{1}{2}} y^{\frac{1}{2}} \dot{y}}{\sqrt{n^2 + 2fy - y^2}} + \frac{\frac{1}{2} m^{\frac{1}{2}} z^{\frac{1}{2}} \dot{z}}{\sqrt{n^2 + 2fz - z^2}} \text{ is } = -\text{the flux. of the tang. dt};$$

and it appears, by the last article, that

$$\frac{\frac{1}{2} m^{-\frac{1}{2}} n^2 y^{-\frac{1}{2}} \dot{y}}{\sqrt{n^2 + 2fy - y^2}} + \frac{\frac{1}{2} m^{-\frac{1}{2}} n^2 z^{-\frac{1}{2}} \dot{z}}{\sqrt{n^2 + 2fz - z^2}} \text{ is } = 0;$$

$m n^2 - n^2 y - n^2 z - m y z$ being $= 0$.

Therefore, by addition, we have

$$\frac{1}{2} y^{-\frac{1}{2}} \dot{y} \times \left[\frac{n^2 + m y}{m - y} \right]^{\frac{1}{2}} + \frac{1}{2} z^{-\frac{1}{2}} \dot{z} \times \left[\frac{n^2 + m z}{m - z} \right]^{\frac{1}{2}} \\ = -\text{the fluxion of the tangent dt.}$$

Consequently, by taking the correct fluents, we find the *tang. dt* ($=$ the *tang. fw*) $=$ the *arc* ad — the *arc fg*! the abscissa cp being $= n \times \left[\frac{z}{m} \right]^{\frac{1}{2}}$,

the abscissa $cr = n \times \left[\frac{y}{m} \right]^{\frac{1}{2}}$, and their relation expressed by the equation $n^6 - n^4 u^2 - n^4 v^2 - m^2 u^2 v^2 = 0$, u and v being put for cp and cr respectively. Moreover, the tangents dt , fw , will each be $= \frac{m^2 uv}{n^4}$; and $ct \times cw = cv^2 = ac \times cg$.

If for the semi-transverse axis cg we substitute b instead of $\sqrt{m^2 + n^2}$, the relation of u to v will be

expressed by the equation

$$n^6 - n^4 u^2 - n^4 v^2 - \frac{b^2 - n^2}{n^2} \times u^2 v^2 = 0, \text{ and}$$

$$dt (=fw) \text{ will be } = \frac{b^2 - n^2}{n^3} \times uv.$$

If u and v be respectively put for fr and dp , their relation will be expressed by the equation

$$b^6 - b^4 u^2 - b^4 v^2 + \frac{b^2 - n^2}{b^2} \times u^2 v^2 = 0, \text{ and}$$

$$dt (=fw) \text{ will be } = \frac{b^2 - n^2}{b^3} \times uv.$$

10.

Suppose $y =$ to z , (that is, $v = u$) and that the points d and f coincide in e . In which case the tangent dt will be a *maximum*, and $= cg - ac$. It appears then that the *arc* ae — the *arc* eg is $= cg - ac$.

Consequently, putting E for the quadrantal arc ag , we find that the *arc* ae is $= \frac{E + b - n}{2}$.

$$\text{the arc } eg = \frac{E - b + n}{2}!$$

There are, I am aware, some other parts of the *arc* ag , whose lengths may be assigned by means of the whole length (ag) with right lines; but to investigate such other parts is not to my present purpose.

11.

Taking m and n each $= 1$; that is, $ac (=AC) = 1$, and $cg = \sqrt{2}$; let the *arc* ag be then expressed

pressed by e : put c for $\frac{1}{2}$ of the periphery of the circle whose radius is 1; and let the *whole fluents* of

$\frac{\frac{1}{2} x^{\frac{1}{2}} z}{\sqrt{1-z^2}}$ and $\frac{\frac{1}{2} x^{-\frac{1}{2}} z}{\sqrt{1-z^2}}$, generated whilst z from 0 be-

comes $= 1$, be denoted by F and G respectively.

Then, by what is said above, $F + G$ will be $= e$;

and, by my theorem for comparing curvilinear areas, or fluents, published in the *Philos. Transact.* for the year 1768, it appears that $F \times G$ is $= \frac{1}{2} c$. From

which equations we find $F = \frac{1}{2} e - \frac{1}{2} \sqrt{e^2 - 2c}$,

and $G = \frac{1}{2} e + \frac{1}{2} \sqrt{e^2 - 2c}$.

But m and n being each $= 1$, L is $= F$; therefore $1 + \sqrt{2} - 2AE$, the value of L , from Art. 5.

is, in this case, $= \frac{1}{2} e - \frac{1}{2} \sqrt{e^2 - 2c}$. Consequently, in the *equilateral hyperbola*, the arc AE , whose abscissa

BC is $= \sqrt{1 + \frac{1}{\sqrt{2}}}$, will be $= \frac{1}{2} + \frac{1}{\sqrt{2}} - \frac{1}{2} e + \frac{1}{2} \sqrt{e^2 - 2c}$,

by what is said in the article last mentioned. Hence the *rectification* of that arc may be effected by means of the circle and ellipse!

The application of these *Improvements* will be easily made by the intelligent Reader, who is acquainted with what has been before written on the subject. But there is a theorem (demonstrable by what is proved in Art. 8.) so remarkable, that I cannot conclude this disquisition without taking notice of it.

Let $lpqn$ (fig. 3.) be a circle perpendicular to the horizon, whose highest point is l , lowest n , and center m : let p and q be any points in the semicircumference $lpqn$: draw ps , qt parallel to the horizon, intersecting lmn in s and t ; and, having joined lp , pt , make the angle lpv equal to ltp , and draw rv parallel to qt , intersecting the circle in r , and the diameter lmn in v . Let a pendulum, or other heavy body, descend by its gravity from p along the arc $pqrn$: the body so descending will pass over the arc pq exactly in the same time as it will pass over the arc rn ; and therefore, qt and rv coinciding when lt is equal to lp , it is evident that the time of descent from p to q will then be precisely equal to *half* the time of descent from p to n !

And it is farther observable, that, if pqn be a quadrant, the *whole* time of descent will be

$= \frac{a}{b} \left\{ \frac{1}{2} \pi + \frac{1}{2} \sqrt{e^2 - 2c} \right\}$; the radius lm , or mn , being $=a$; and b being put (for 16 $\frac{1}{4}$ feet) the space a heavy body descending freely from rest falls through in one second of time.

In general, ns being denoted by d , and the distance of the body from the line ps , in its descent, by x , the fluxion of the time of descent will be expressed by

$\frac{\frac{1}{2} a b^{-\frac{1}{2}} x^{-\frac{1}{2}}}{\sqrt{2ad - d^2 - 2a - 2d \cdot x - x^2}}$; the fluent whereof,

corresponding to any value of x , may be obtained by Art. 7. By which article it appears, that the *whole* time

time of descent from any point p will be

$$= \frac{a}{b^{\frac{1}{2}} d^{\frac{1}{2}} \times 2 a - d} \times E + 2 A E - p n - p s.$$

The semi-transverse A C (fig. 1.) being $= n s$;
 the semi-transverse c g (fig. 2.) $= n p$;
 and the semi-conjugate in each figure $= p s$.

Since writing the above, I have discovered a general theorem for the rectification of the Hyperbola, by means of two Ellipses; the investigation whereof I purpose to make the subject of another Paper.

XXXVII. *A Letter from Mr. John Reinhold Forster, F. A. S. to the Hon. Daines Barrington, Vice-Pref. R. S. on the Management of Carp in Polish Prussia.*

Somerset-house Stable-yard, May 29, 1771.

DEAR SIR,

Read June 13, 1771. **Y**OU was so kind as to judge favourably of the few hints I threw out in a conversation, about *the management of Carp* in Prussia and in the electorates of Brandenburg and Saxony, and desired me to collect my observations upon that subject, into a small *mémoire*. Though I am very sensible, that there are many more capable of giving a satisfactory account of the management of carp; I will, however, to obey your friendly commands, communicate to you such observations as I can collect from my own experience; from the methods observed in Prussia, Brandenburg, and Saxony, where I had opportunities to enquire into the subject, during my stay in these countries; and lastly, from the instructions of an anonymous German patriot, in a book, intitled, *A System of all the Sciences relative to Oeconomy and the Finances*. In case you find these obser-

observations deserving to be laid before the Royal Society, I shall think myself very much honoured by it.

I am, with the sincerest sentiments of gratitude and regard,

DEAR SIR,

Your much obliged humble servant,

John Reinhold Forster.

Observations on the best way of managing Carp, from real experience, and the best methods now in use.

IT would be needless to speak of the natural history of this well-flavoured fish, after the satisfactory account given of it in the *British Zoology* *, by that most accurate zoologist Mr. Pennant. I will only observe this, that though the carp is now commonly found in ponds and rivers, and generally thought to be a fresh-water fish †, the ancient zoologists ranged

* British Zool. Vol. III. p. 300, &c.

† I have great reason to think, that many other fish, which, it is commonly conceived, can only live in the sea, may also exist, at least for several years, and perhaps breed, in fresh water.

the same among the sea-fish : and I know instances of its being caught in the harbour of Dantzic, between that city and a little town called Hela ; which

The finelt or sparling (*Salmo Eperlanus* Linnæi) never comes up our rivers, but for a short time ; and then does not penetrate much further than where the water continues to be brackish.

I have, however, been informed by Sir Francis Barnard (the late Governor of New England) that in a large pool which he rented not far from Boston, and which had not the least communication with the sea, several of these fish, originally introduced from the salt water, had lived many years, and were, to all appearance, very healthy.

I have also the following well-attested fact with regard to the common grey mullet, which it is believed was never before taken in fresh water.

Mr. Kymer hath made, near Kidwelly in Carmarthenshire, a communication between his collieries and an arm of the sea, by means of a canal.

Before this canal was completed, the salt water filled it at every tide, and several mullets were by this means introduced.

For these three or four years, the sea hath been entirely excluded ; and the canal, from the constant influx of fresh water, hath ceased to be brackish for more than two years.

The mullets, however, continue to live in this canal ; though Mr. Kymer informs me, they do not look in so good condition, as when fresh from the sea.

We are so much in the dark about the natural history of fish, particularly those of the salt water, that it is to be wished sea stews were made on some of our coasts, as I am told is very commonly practised in North America, and for a very trifling expence.

Nothing more is requisite, than either to find or dig a proper cavity, perhaps a yard below the low water mark, at spring tides, from which the sea should be excluded, except at a narrow entrance, where large stones should be piled from the beach to above the high water mark.

Through such an inlet, the stew would be every twelve hours, supplied with fresh salt water, at the same time that the fish would not be able to make their escape.

is situated at the extremity of a long, narrow, sandy promontory, projecting Eastwards into the sea, and forming the gulf before Dantzic, of about 30 English miles diameter. These carp were forced, as I suppose, by a storm, from the mouth of the Vistula, which here enters the Baltic, into the sea : and as the other two branches of the Vistula or Weixel disembogue into a large fresh water lake, called the Trish-Haff, which has a communication with the sea at Pillau ; it is equally probable, that these fish came round from Pillau, to the harbour of Dantzic ; especially as they are frequently found in the Trish-Haff.

The sale of carp makes a part of the revenue of the nobility and gentry in Prussia, Pomerania, Brandenburg, Saxony, Bohemia, Mecklenburgh, and Holstein ; and the way of managing this useful fish is therefore reduced in these countries into a kind of system, built on a great number of experiments, made during several generations, in the families of gentlemen well skilled in every branch of husbandry.

The first thing which must be attended to, in case a gentleman chooses to have carp-ponds, is to select the ground where they are to be made :

By this very easily-contrived reservoir, sea-fish, when caught in too great numbers, might be kept for the supply of the table or market, when perhaps the weather will not permit them to be taken ; and many ingenious experiments might be tried.

It is not impossible (for example) that the fish of the fresh water might be improved, by continuing in such a stew for a fortnight or three weeks, as horses are said to thrive by feeding on the salt marshes.

Daines Barrington.

for upon the soil, water, and situation of a pond, the success in the management greatly depends. The best kind of ponds ought to be situated in a well-manured, fertile plain, surrounded by the finest pastures and corn fields of a rich black mould, having either mild or soft springs on the spot, or a rivulet that runs through the plain; the water ought to be mild and soft, by no means too cold, or impregnated with acid, calcareous, selenitic, or other mineral particles. The exposure must be sheltered against the cold blasting Easterly or Northern winds, by a ridge of hills, situated at some distance from the pond, enjoying fully the benign influence of the sun, far from any thick shady wood, that might intercept the beams of the sun, or where the leaves of trees might cause a putrefaction, or impregnate the water with astringent particles.

Such ponds as are surrounded by poor, cold, and stiff soils, are open to the East and North winds, have a wood on one or two sides, and hard or cold water, or such as issues from mines, moors, or mosses, are inferior and improper.

Ponds in a poor, dry, or sandy soil, surrounded by pines or firs, with the just-mentioned inconveniences, are considered as the worst of all.

The ground towards the pond ought to have a gentle slope; for deep vallies are subject to great floods, and will then endanger the dikes in a wet rainy season; and often the expectations of many years are carried away.

The soil cannot be altered; it is therefore a chief qualification of a pond, to be contrived in a good soil.

The

The sun is a less material article ; provided therefore a pond can enjoy the morning and noon-tide sun, it matters not much if the wood be on one or two of its sides.

The water is a material point ; but in case the springs that supply the ponds are very cold and hard, it may be softened and tempered by exposing it to the sun and air in a large reservoir above the pond, or by leading it for a long way in an open exposure, before it enters the pond.

The quantity of water to supply the pond with, is another requisite ; too much water makes too great a canal necessary, for carrying its superfluity off ; and this is very expensive ; too little water has another inconvenience, *viz.* that of keeping the water too long in the pond, and to cause a stagnation, without any sufficient fresh supplies ; and often, in a dry season, the scantiness of fresh water distresses the fish, and causes diseases and mortality among them.

The above remarks are general, and must be applied to all kinds of ponds ; but now I will enter into a more minute detail : it is found by experience most convenient, to have three kinds of ponds for carp. The first is called the spawning-pond ; the nursery is the second ; and the main-pond is the third and largest.

There are two methods for stocking the ponds with carp ; either to buy a few old fish, and to put them into a spawning-pond ; or to purchase a good quantity of one year's old fry, for the nursery. I will treat of both methods, and will add something about the management of carp in the main-pond.

A pond intended for spawning, must be well cleaned of all other kinds of fish, especially such as are of a rapacious nature, viz. pike, perch, eel, and trout; and also of all the newts or *larvæ* of lizards, and the *dytisci* or water-beetles, which frequently destroy quantities of the fry, to the great loss of the owner.

A rich soil, gentle sloping banks, mild springs, or a constant supply of good soft water, with a fine exposure in regard to sun and air, are the chief requisites for a good spawning-pond.

A pond of the size of about one acre, requires three or four male carp, and six or eight female ones; and thus further, in proportion to each acre, the same number of males and females.

The best carp for breeders are five, six, or seven years old, in good health, in full scale, without any blemish or wound (especially such as are caused by the *lernea cyprini* Linn. a kind of cartilaginous worm) with fine full eyes and a long body. Such as are short, more hot-brinkly, have spots as if they had the small-pox, have either lost their scales, or have them sticking but loosely to the body, whose eyes lie deep in their heads, are short, deep, and lean, will never produce good breed.

Being provided with a set of such carp as are here described, and sufficient to stock a pond with, it is best to put them, on a fine calm day, the latter end of March or in April, into the spawning-pond. Care must be taken, that the fish be not too much hurt by being transported in a hoghead; nor put into the pond on a stormy day; for they are easily thrown upon

upon the shallows on the sides, being weak and harrassed by being caught, removed, and not yet acquainted with the deep holes for their retreat, in the new habitation.

Carp spawn in May, June, or July, according as the warm season sets in earlier or later. The warm weather expands and swells gently the bodies of the fish; and their bellies being distended with roe and milt, they feel an itching about those turgid parts, and therefore swim to a shallow, warm, sheltered place, where the bottom of the pond is either somewhat sandy or gritty, where some grass and aquatic plants grow, or where some ozier branches and roots hang in the water; they gently rub their bodies against the ground, the grass, or oziars, and by this pressure, the spawn issues out; and as the milt, by a natural instinct, follows the spawner, and feels the same itching, the calls of nature are gratified in the same manner, and the soft roe or milt is spread over the spawn, and thus impregnated. Carp in this season are frequently seen swimming, as if it were in a circle, about the same spot, which is merely done with an intention of repeating the rubbing of their expanded bellies. The finest and calmest summer days are commonly those on which carp spawn; providence having thus made a provision for the greater security of the fry of so useful a fish; as otherwise, in a stormy day, the spawn would be washed towards the banks, where it would be eaten up by birds, or trampled upon by men and quadrupeds, or dried up by the heat of the sun, and a whole generation of carp entirely destroyed. In a pond of my uncle's, I frequently found the carp in a warm summer evening, round a large

large stone, rubbing their bellies against the hard sandy ground; I often approached with as much silence as possible, put my hands and feet among the sporting carp, and had the satisfaction to see them pass and repass through my hands, without being in the least disturbed; but at the least noise or quick motion occasioned by me, they moved away with surprizing velocity.

About the spawning season, great care must be taken, to keep out all aquatic fowl, wild and tame, from the ponds; for geese and ducks not only swallow the spawn, but destroy still more of it, by searching the weeds and aquatic plants. It is therefore a general rule, to send twice a day, a man round the ponds, to scare all wild fowl, viz. swans, geese, ducks, cranes, and herons.

Sometimes crucians and carp, or tench and carp, being put together in a pond, and the males and females of each kind not being in a just proportion one to another, the different species mix their roe and milt, and thus produce mules or mongrel breeds.

The mules, between carp and crucians*, seldom and slowly attain the size, which carp are capable of;

* The fish thus named is supposed to be the same with the rud or finscale (See Br. Zool. Vol. III. p. 310.). It is not very common in England, and is generally esteemed to be much inferior to a carp in point of flavour, which I rather conceive to arise from its being placed in improper ponds, or eaten when it is not fully in season, as our countryman Mr. Henshaw gives the following account of the karouffe (*cyprinus carassius* of Linnæus). "The crawfish of that country (meaning Denmark) are at least twice as big as ours, and are excellent meat; but the choicest pond fish they have, is called *karouffe*,"

they are very deep, and shorter in proportion than carp, but of a very hardy nature.

The mules between carp and tench, partake of the nature of both fish, come to a good size; but some part of their body is covered with the small slimy scales of a tench, and some other part has the larger scales of carp; their flesh approaches nearer to that of a tench, and they are likewise of a less tender nature than the common carp: this latter kind of mule is called in Germany *spiegel-karpe*, i.e. the *mirror-carp*, the blotches with large scales among the smaller ones being considered as mirrors.

Whether these mules are capable of propagating their species, I cannot affirm; never having made any experiments on that subject; nor have I heard any thing said on that head with any degree of precision, or founded on experience. In some ponds in Lancashire, I was told, by a gentleman of great worth and honour, both these kinds of mules are now and then found.

I think it, however, not adviseable, to put carp and tench, or carp and crucians, in one pond, unless it be done for experiment's sake; in which latter case, a small pond, free from other fish, with one or two fish of each kind, will be sufficient to gratify curiosity, without debasing a generation of carp in a large pond.

"somewhat resembling a roach, with his red fins, but it is
"near as big as the largest carp, and much better meat."

Dr. Birch's Hist. R. S. Vol. III. p. 187.
D. B.

The

The young fry being hatched from the spawn, by the benign influence of the sun, they are left the whole summer, and even the next winter, in the spawning-pond, in case the pond be so deep, that the suffocation of the young tender fry under the ice in a severe winter, is not to be apprehended, for it is by no means advantageous to take them out in the first months of their existence. However, if the shallowness of the pond, its cold situation and climate, make it necessary to secure the fry against the rigours of the ensuing winter, the water of the pond must be let off; the fry and old fish will gradually retire to the canal and ditches, which communicate with the hole in the middle of the pond, and a net, with small meshes, is then employed to catch both the fry and old ones. The old breeders are then separated from the fry, and both kinds put in separate ponds, that are warmer and more convenient for the wintering of these delicate fish. Care must be taken, to fix upon a calm, mild day, at the latter end of September, for the catching of the fry out of the spawning-pond.

The nurseries are the second kind of ponds intended for the bringing up the young fry. The best time to put them into the nursery is in March or April, on a fine and calm day. A thousand or twelve hundred of this fry may be allotted to each acre of a pond. The choice of the fry must be made according to the above enumerated characters of good and healthy fish, and must be carefully removed from one pond to another. It is likewise requisite to send people with long sticks, all the first day, round the pond, in order to drive the tender and weak fry from the sides into the pond, because they are be-

wildered

wildered in a strange place, and often become the prey of rapacious birds*.

In case the pond be good, and not overstocked before, and the fry well-chosen and preserved, it is almost certain, they will grow within two summers so much as to weigh four, five, and sometimes six pounds, and to be fleshy and well-tasted. A great many Prussian gentlemen make a good profit, by selling their carp, after two years standing in the nursery, and export them even to Finland and Russia.

The main-ponds are the last kind. In these, carp are put, that measure a foot, head and tail inclusive. Every square of fifteen feet in the pond is sufficient for one carp, and will afford food and room for the fish to play in. The more room carp have, and consequently the more food the pond affords, the quicker will be the growth of the fish. The longer the pond has been already in use, the longer you intend to keep the carp in it, the more you desire to quicken the growth of them, the more you ought to lessen the number of fish destined for the pond. Spring and autumn are the best seasons for stocking your main-ponds. The growth of your fish will always be in proportion with the food they have: for carp are observed to grow a long time, and to come to a very considerable size, and a remarkable weight. I recollect to have seen carp above a yard long, and of 25 pounds weight; but I

* I have reason to think that the common carrion crow should be added to the list of birds, which Mr. Forster hath before supposed destroy fish when in shallow waters, as I once saw this bird taken by a trap, which was baited with a fish for a heron.

D. B.

had no opportunity to ascertain their real age. In the pond at Charlottenburg, a palace belonging to the king of Prussia, I saw more than two or three hundred carp between two and three feet long; and I was told by the keeper, they were between 50 and 60 years standing: they were tame, and came to the shore in order to be fed; they swallowed with ease a piece of white bread, of the size of half a half-penny roll.

During winter, ponds ought to have their full complement of water; for the deeper the water is, the warmer lies the fish. In case the pond be covered with ice, every day some holes must be opened, for the admission of fresh air into the pond, for want of which frequently carp perish.

In the summer, observe to clean the rails and wire-works, in the water-courses, of the weeds and grass, which frequently stop them up. Birds that feed on fish must be carefully kept out of the ponds. In a great drought, provision ought to be made, to keep the water at the same height as it commonly stands in the pond, *i. e.* between four and five feet. If the water stagnates and grows putrid, it must be let off, and a supply of fresh water be introduced from the reservoirs. If the weeds, especially reed and flags, and some of the aquatic grasses, over-run too much the pond, scithes fixed on poles of 16 or 20 feet, with a lead fastened to them to keep the scithes on the bottom of the pond, are thrown out, and then again drawn to the person that works with them, and the weeds will all be cut; after which operation, they must be drawn up by long harrows, and set in heaps on the shore for putrefaction, and in length of time,
for

for manure. This cleaning of ponds, must never be done in a spawning-pond, where it would be the destruction of thousands of fish.

Autumn is the best season for catching such carp as are intended for the market. After the pond has been for five or six years in constant use, it is likewise time to let the water entirely off, and clear the pond of the mud, which often increases too much, and becomes a nuisance. When the pond is dry, it may be ploughed before the frost sets in, and next spring oats or barley should be sown in it, after a new ploughing; and it will repay the trouble to the owner with a rich and plentiful crop. When the loose superfluous mud is carried off out of the pond, care ought to be taken not to take the soil below the original level of the pond.

Some people sow a pond, which hath been laid dry for some months, with oats; and when they are growing, they fill the pond with water, and introduce carp for spawning, and think, by this contrivance, to procure food for the fish and something to rub their bellies against. But this practice seems to be more noxious than beneficial; for the growing oats will putrefy, and communicate putridity to the water, which can by no means be salutary to the fish.

The epicures sometimes feed carp, during the colder season, in a cellar. The following method is the best that can be observed for that purpose. A carp is laid on a great quantity of wet moss, spread on a piece of net, which then is gathered into a purse, and the moss so contrived, that the whole fish be entirely wrapt up in it: however, care must be taken to give the fish ease, and not to squeeze it, so that

it may have room to breathe in this confined attitude. The net with the fish and moss is then plunged into water and hung up to the ceiling of the cellar. In the beginning, this operation must be very frequently repeated, at least every three or four hours; by length of time the fish will be more used to the new element, and will bear to be out of water for six or seven hours *. Its food is bread soaked in milk, which, in the beginning, must be administered to the fish in small quantities; in a short time the fish will bear more and grow fatter. I saw the experiment tried in a nobleman's-house, in the principality of Anhalt-Deffau; and during a fortnight, I visited myself, every day, the fish, together with the young nobleman, my friend, whom I accompanied to his seat from the university, during the Christmas-vacation. After the fish had been kept in the above manner during a fortnight, it was dressed and served up at dinner, when every one present found it excellent in its flavour. At my late uncle's, I had an opportunity of repeating the experiment on a carp

* It is known to every one that a carp will live a great while out of water; but perhaps it may not be so notorious, that the keeping him several hours in the common air, without any precautions, may be repeated from day to day, without any apparent inconvenience to the fish.

There is a fishmonger near Clare-market, who, in the winter, exposes for sale, a bushel at least of carp and tench, in the same dry vessel: but a small proportion of these can be sold in a day; and I have frequently been informed, that the fish continue in good health, notwithstanding their being thus exposed to the air six or seven hours for several successive days.

D. B.

that

that had been brought 20 miles wrapt up in wet moss; but after the fish had been kept three days in wet moss, during which it was fresh and healthy, it was employed to regale a friend, whose unexpected arrival accelerated its fate, before the experiment was finished.

John Reinhold Forster.

XXXVIII. *An Account of the remarkable Cold observed at Glasgow, in the Month of January, 1768; in a Letter from Mr. Alexander Wilson, Professor of Astronomy at Glasgow, to the Rev. Mr. Nevil Maskeline, B. D. F. R. S. and Astronomer Royal.*

Reverend SIR,

College, Glasgow, May 29, 1771.

Read Nov. 7;
1771.

HAVING of late had some leisure time, I have made out from my minutes, a detail of the remarkable cold which prevailed here in the month of January, 1768; the intensity of which being so extraordinary for this climate, an account of it may perhaps be thought worthy of a place in the Philosophical Transactions.

Whilst in bed, on Sunday morning, January 3, 1768, about 8 o'clock, it felt somehow unusually cold. A little while after, on reaching out for a decanter which I had placed near me the preceding night,

night, with some water in it, I was surprized to find the surface of the water frozen over, the like not having happened before in that place. Upon this, I desired my son to try the cold by a thermometer, as I imagined it behooved to be very intense. The experiment was soon after made, by exposing a thermometer at a high North window, and free from the walls of the house; in which situation it had not remained for a quarter of an hour, when we found the mercury had fallen so low as to 5 deg. of Fahrenheit's scale.

Although I had expected a great degree of cold, yet I was not quite prepared for so extraordinary a report as that which the thermometer now gave me. My doubts were, however, soon settled, by examining matters with more attention, and by finding the first thermometer verified by my standard one, which was now hung out beside it.

Being thus satisfied that there was no fallacy in this preliminary observation, it naturally occurred, that the cold, however intense it now was, might have been much more so at some earlier hour of the morning. But how to ascertain this, and to recover the lost observation, was the difficulty. In the eagerness of our disappointed curiosity, we were disposed to magnify this golden opportunity, which had now escaped us, and to reflect upon it with regret, when luckily a little invention helped us out. A notion suggested itself, that, if we went very warily to work, we might perhaps surprize those imagined colds still lurking under the surface of the snow, which at that time lay thick upon the ground.

I need not mention upon what principles of the heating and cooling of bodies this expectation was founded, as they will readily occur of themselves. The fact was, that I immediately repaired to the fields, and sought out a low place, upon which the sun had not then risen; here I laid the thermometer in the snow, almost upon the very surface, when presently the mercury sunk from $+6$ deg. to -2 deg. which therefore I concluded to have been pretty nearly the coldest temperature of the air over night.

The next thing was, to make regular observations with the thermometer, so long as the cold promised to continue remarkable. The instrument was hung upon a pole near to the observatory, and to the windward of it, care having been also taken to keep it under a proper shade, so long as the sun shone out.

Register of the Thermometer, kept at the M'Farlane observatory, of the college of Glasgow, on sunday January 3, and monday January 4, 1768.

Sunday	10 o'clock	$+ 5$ deg.	
morning	11	7	
	12	9	
afternoon	1	10	The temperature of the snow on sunday morning, at about ten inches below the surface, was near to 30 deg.
	2	11	
	3	$9\frac{1}{2}$	
	$3\frac{1}{2}$	$6\frac{1}{2}$	
	4	$3\frac{1}{2}$	
	$4\frac{1}{2}$	2	
	5	$1\frac{1}{2}$	
	$5\frac{1}{2}$	$2\frac{1}{2}$	
	6	$1\frac{1}{2}$	
	$6\frac{1}{2}$	$0\frac{1}{2}$	
	7	—	1
	$7\frac{1}{2}$	—	$0\frac{1}{2}$

	8	—	0½	
	8½	—	1	
	9	—	2	
	9½	—	1	
	10	—	2	
	10½	—	2	
	11	—	2	
	11½	—	1	} Some appearance of clouds in the S. E..
	12	—	0	
	12½	—	0½	
Monday morning	1.	—	1	
	2	—	0	
	2½	+	3	} Clouds gathering, and some wind from E..
	3		6	
	3½		7	
	4		9	Quite overcast, wind E.
	4½		10	Ditto
	5		12	Ditto

It was observable, that after sun setting, the atmosphere had a tendency sometimes to turn a little foggy, and again quickly to clear up, balancing, as it were, betwixt these two different states. It is worthy of notice, that the minute variations of the thermometer, as set down in the above register, seemed to depend upon these different constitutions of the air; the mercury always rising in the thermometer a small matter, when the mistiness came on, and *vice versa*.

In the intervals of observations, we made some other experiments, which the present intensity of the frost suggested; particularly one relating to the evaporation of ice, which was tried in the following manner. I took a square reflecting metal belonging to my own two foot telescope, and exposed it on the ballustrade of the observatory, till it had acquired the temperature of the place, which was then at 0 deg: after it:

was thus cooled, I breathed on it repeatedly, till its polished surface was covered over with an incrustation of ice or frozen vapour, of a very palpable thickness. In this condition the speculum was replaced in its former situation, having its incruusted surface exposed to the still open air; when, in a little time, we found the frozen pellicle begining to disappear at the outer edge, all around, leaving the metal quite clear. Gradually more and more of the speculum was bared in a regular progression, from the circumference towards the centre; and at last, in about 50 minutes, the whole surface had parted with its ice. This experiment was repeated when the speculum was defended from the open air, by a large thin box, with a cloth over it. The event turned out the same as before, only it required longer time.

This progress of the evaporation from the outward parts towards the centre of the speculum, was likely owing to the original plate of ice being thickest towards the center, a circumstance which might arise from the manner of fixing it at first breathing on it. Or perhaps it may be imputed to some more curious cause, and may be some effect of the repulsive force belonging to the polished surface; but this point we did not sufficiently examine into, by a due repetition of experiments. I may just mention, that, partly with a view to this matter, we exposed as above, a set of bodies, having their surfaces of different degrees of polish, and as equally covered with frozen moisture as we could judge. The result of which experiments seemed to favour the idea of the ice being less attached to the more polished surface than to the coarser. This appeared particularly in the
case

case of a comparison made betwixt the speculum above-mentioned, and the brass end or cover of the same telescope; for the ice was found still to cleave to its surface a good while after the speculum was entirely cleared. These imperfect experiments are only mentioned by the bye, and may perhaps serve as hints to others, who may be disposed to prosecute this part of natural philosophy.

Some particular reasons have occurred, which will hinder me from transmitting to you the paper on the solar spots, till some time next winter, by which time I shall have finished every thing I have to say on that subject. Wishing to hear from you at your leisure, I ever am, with much respect,

Reverend Sir,

Your most obedient servant,

Alexander Wilson,

Professor of Astronomy at Glasgow.

Received November 15, 1770.

XXXIX. *Some Experiments on Putrefaction;*
by F. L. F. Crell, M. D. and Professor
of Chemistry at Brunswick.

Read Nov. 7, 1771. **T**HE celebrated lord Bacon [a] has, without doubt, shewn a very great sagacity, in pointing out to posterity, putrefaction, as a subject, worthy of making further inquiries into; and certainly, as there happen daily so many changes, not only in the inanimate, but also in the animate world, carried on by its means; the knowledge of every thing relating to it must clear up a great many points in natural philosophy, not thoroughly understood before. But these inquiries ought to be still of more consequence to mankind, as health depends greatly upon keeping in due bounds putrefaction, which the body naturally tends to. For these reasons, Sir John Pringle deserves, besides his other eminent merits, very great praises, on his having made many experiments on this subject; and medicine is indebted to him for considerable improvements resulting from them. He has besides opened

[a] Nat. Hist. Cent. IV.

the way to many other gentlemen, among whom excell Dr. Gaber, and Dr. M'Bride, whose numerous experiments shew the ingenuity, and sagacity, they are possessed of : but the subject is not yet exhausted, nor will it be very easily. I have made some experiments relating to it; and should be very glad, if they threw a new light on some points of the greatest importance to medicine.

Dr. Gaber has proved, by his experiments, the presence of a volatile alcali produced by putrefaction; but as he did not discover by the same proceedings [b] any in its beginning or end, though there was a very putrid smell, he denies its existence in these states, and concludes, that this volatile alcali is not a necessary product of putrefaction [c]. This doctrine seemed to me not quite conformable to the phenomena: for, as all smell, as much as we know at least till now, depends on a saline matter, joined with a

[b] *Acta Taurinens.* Vol. I. p. 78. Cum attingerint summum effervescentiæ gradum, continuato ejusdem loci calore effervescentiæ vim amiserunt. P. 79. Citius plerumque prodit foetor, quam alkali, idemque tardius desit. P. 82. Massam inde relinquit foetentissimam, sed emissio alkali ad effervescentiam ineptam.

[c] *Id.* p. 83, 15. Quum fosteret gravissime residuum destillationis, quamquam omni alkali orbatum, manifestum videtur, ab alkali foetorem exaltari quidem posse, & magis penetrantem effici, non autem ab eodem produci, quandoquidem superest eo sublato—16. Videtur is odor a volatilibus admodum particulis proficisci, sed quæ ab alkali dissimiles sunt, plerumque citius gignantur, tardiusque dissipantur—alcalescentia adesse potest medico foetori conjuncta—vicissim maximus foetor absque alcali—Ex quibus differentia inter foetidas alcalinasque partes confirmari videtur.—P. 84, 17. Videtur alcali non esse productum necessarium putrefactionis neque gradum alcaliescentiæ gradui putrefactionis respondere.

phlogiston, and the saline matter producing the putrid stench, was not very likely an acid; I supposed it to be a volatile alkali, which, involved in phlogistic matter, might fly off, before the alkali was developed. I wanted to know by experiment, if I was right; for this purpose, I put, the 19th of June (the thermometer being 58° of Fahrenheit, and continuing between 58° and 62° all the time I observed), in a pretty large receiver, some beef cut in very small pieces; I covered the bottom with it thinly, and poured upon it water, about two inches high. The 22d, the putrid smell was very sensible: but I let it stand till the 24th, when I poured off the fluid [d], adding again about the same quantity of water to the flesh. I filtrated then the fluid through a piece of fine linen, and mixed with some of it the syrup of violets, which it did not alter; neither did it effervesce with the spirit of vitriol, diluted to a sharpness near that of the vegetable acid. I thought of keeping it in digestion for some days; but, for fear that some little solid particles might have passed through the linen, and by that means, in growing putrid, might give some alkali, and render the trial inaccurate, I distilled the fluid by a heat of about 160° , after which, I repeated the trial with the syrup of violets and the spirit of vitriol, but it produced no

[d] It requires some attention to find out the proper time when to pour off the liquor, if it is done too soon, it will give too little volatile alkali to be much sensible by experiments; for, though it smells strongly, it is known how little matter is required to produce a strong smell. If it is delayed too long, it shews already signs of an alkali. For that reason, I made many experiments in vain.

change.

change. I then put it, the 25th, into a retort, fitted to it a receiver, applied to the jointure a ring of paste made of flower and water, covered it with a piece of wet bladder, and exposed it in a *balneum arenæ* to a heat of 108° to 116° , till the 29th of June, when the whole fluid was distilled over. I perceived during this operation, that the liquor, from being quite transparent, grew turbid; the first distilled transparent fluid grew also turbid in the receiver, and at the bottom of the retort there was a small settlement of a whitish earth. The liquor had a particular smell, but quite different from a putrid one, inclining to the volatile alkali; and shewed a slight but sensible degree of effervescence with the spirit of vitriol; and the syrup of violets was turned evidently green by it.

In the mean time, the flesh with the water continued to emit a putrid stench; and the 28th of June I found the fluid colouring the syrup of violets greenish, and shewing a kind of effervescence with the acid. Both these qualities were increasing every day, till the 8th of July, when, on account of a journey, I could not observe it any longer. I had left the mouth of the receiver open; and on my return the 1st of August, I found an exceeding putrid smell; I covered the vessel; and the 2d, examined the fluid, but it did not effervesce any more. I then filtrated the liquor; but the flesh was so rotten, that a great many particles passed through the linen, and rendered it turbid. I put it into a retort, adapted a receiver, and luted it, as before-mentioned; the heat was also the same, between 108° and 116° . In this warmth it continued for about four days, when the fluid was distilled

distilled over. On opening the vessels, the smell was again entirely changed, not near so disagreeable as before. In the receiver I obtained a fluid, which turned the syrup of violets green, effervesced very smartly with the very same spirit of vitriol I had used before; gave the smell of a volatile alkali, on adding to this the fixed alkali; praecipitated the calces of metals dissolved in acids, and shewed itself by all proofs a true volatile alkali. In the retort remained a yellowish matter, almost without any smell. I put to it some water; and after 24 hours, it gave the herbaceous smell, but shewed no signs of any alkali. I let it stand four days longer: the herbaceous smell continued; but there was no alkali to be discovered. I distilled it with a gentle fire: but neither then did there appear an alkali [e]; and by applying a stronger fire, I got nothing but a kind of empyreumatic oil.

I had poured, the 3d of August, some fresh water on the putrid matter; its putrid smell continued; the 7th I decanted the fluid, filtrated it, and made it undergo the same operation, with exactly the same effect as before; which I did again the 11th, with the very same effect. I did not repeat it oftener, as I had occasion for this putrid flesh to some other purpose.

These experiments shew, I think, that the volatile alkali is present as long, at least, as the putrid smell:

[e] What this herbaceous smell did depend on, I did not enquire any farther, as not relating to medicine, since a living body never was found in such a state: but very likely it depends on some volatile alkali, which is perhaps in so very small a quantity as not to be perceptible by experiments.

continues,

continues; and that this volatile alkali is the basis of it, because, as this was distilled over, the residuum, being still in intestine motion, got only the herbaceous smell. The reason, why the volatile alkali has been distinctly observed at a certain period of putrefaction, and not in the others, is, I believe, this; the volatile alkali has, it seems, a tendency, to disentangle itself, by intestine motion, of all such matter as it is involved with; but if it is not combined with such fixed matter as retains it till it has gone through all its evolutions, it is, being itself volatile, carried off by the still more volatile phlogistic matter with which it is commonly joined. For this reason, I suppose, the putrefying matter shews in its beginning no sign of a volatile alkali; because its smell depends only on those particles, which have been on the surface, without any strong cohesion with the substance. In the farther progress of putrefaction, the matter involving the alkali, or forming it, is intermixed, and in cohesion with the solid particles of the substance, and is by these means retained till the alkali is come to its purer state. Towards the end of putrefaction, the cohesion of the particles being almost entirely taken off, the volatile alkali is carried off before it can go through all its states.

If it is therefore true, that the volatile alkali is essential to, or at least always present in putrefaction, it seems to follow, that the alkalies never can be used in living bodies, as antiseptics [f], for laying

[f] It is very difficult, methinks, to account for the antiseptic power of the volatile alkali, and other salts, on dead animal sub-

aside their stimulating quality, which must prevent their use in most of the putrid diseases, they would increase the morbid matter, by being intimately mixed by circulation with phlogistic matter, which they find in abundance in such bodies. It has been objected to this, that the exhalation of stale urine, though shewing a great quantity of volatile alcali, is inoffensive to health [g]: and that some persons have taken the volatile alcali in very great quantity, without its bringing on a putrid disease [b]: but there

stances: I once thought, that as the ammoniac salt, nitre, &c. bring down the thermometer several degrees, perhaps all these salts acted by instantly absorbing the heat produced by the beginning intestine motion; and that, as a certain degree of warmth is necessary to putrefaction, in preventing this degree from coming on, it might hinder the whole operation. To see by experiment how far this might be true, I put into phials a certain quantity of water, with that proportionate quantity of alcalies, fixed and volatile, sal ammoniac, &c. which Sir John Pringle had found (Append. p. xvi. xvii.) to be antiseptic; and in one as much pure water as a standard. I stopped every one of them with a cork, in which I had made a hole for a thermometer of Fahrenheit. I exposed all these phials to the same heat; Sir John had used about 112; but I found, that both those with the salts and that without it marked the same degree of heat; and that therefore the absorption of heat can by no means be the reason of the putrefaction being stopped. May this phenomenon not depend upon the salts penetrating the body, and giving to the particles more *puncta contactus* (according to their greater or less affinity)? and may not these salts, in augmenting cohesion, hinder the fluids from separating themselves from one another, and, in consequence, prevent intestine motion? Is this not somewhat confirmed by the action of adstringents? and by the most powerful actions of metallic salts, as being of the greatest specific gravity?

[g] Sir J. Pringle, Append. p. vi.

[b] Id. *ibid.* p. xcii.

are however some examples [*i*], where it has been hurtful. It is urged further, that a person, being only for a short time exposed to really putrid exhalations, may be infected with putrid diseases; and therefore that this effect of putrid exhalations does not depend on the volatile alkali, as it may be taken pure in very large doses, without producing such effects. To this I reply, by an analogous instance; a small quantity of ferment will bring on fermentation in a large mass of fermentable matter, and yet as much acid as could be obtained from the ferment, far from exciting an intestine motion in the fermentable matter, would rather check it; but can it, for all that, be denied, that the involved acid in the ferment is the chief cause of setting the whole mass in fermentation? In the same way, the alkali combined with phlogistic matter may produce such intestine motion as the pure alkali cannot; and very likely the first would not produce it, if the volatile alkali in it could be changed.

To bring this about, the most powerful means seem to be the use of acids; and the most celebrated physicians agree in the good effect they have observed from acids in putrid diseases, and recommend them strongly. Dr. M'Bride thinks otherwise, and his reasons are these: *first* that if the acids came unchanged to the absorbent vessels, they would not admit of them [*k*]; *secondly*,

[*i*] Huxham on the sore throat, p. 67, 68. Eijusd. Essay on fevers, p. 118, edit. 5.

[*k*] Experiment. Essays, edit. sec. p. 20. The austere acid (generated in the first passages of weakly persons) is exactly in the same state with a foreign acid, for the lacticals will admit none of it.

if they did, they would be dangerous [1]; and *thirdly* that they are quite changed, before they leave the *primæ viæ* [m]. As for the *first*, I do not know what reasons Dr. M'Bride founds his assertions upon, as acids never are given in so concentrated a state, as by their astringency to make these vessels shut up their orifice; and as metallic salts themselves are absorbed in their very compound state (which seems clear with regard to the corrosive sublimate, and other such saline preparations), I do not see, why the simple acids could not be absorbed. The *second* reason seems to be founded upon some of Dr. M'Bride's experiments (p. 132, 133), *viz.* that putrid flesh, sweetened by distilled vinegar and spirit of vitriol, was firm; but on being boiled went quite to pieces, whereas that sweetened by volatile alkali did not. But, I conceive, these experiments are not applicable to a living body: for the acid being there mixed with the fluids, cannot act in this way on the solids, till the fluids are (if I may use that

[1] *Ibid.* p. 134. the acids dissolve the elementary earth, and thus destroy the texture of that substance, whose foundation they are supposed to restore.—P. 148. we are not to expect, that they are to pervade the minute branches of the vascular system; when indeed it is evident, that they ought not to be allowed to pass into the blood in their acid form; since it is plain, that, from their dissolvent nature, the body must be destroyed, and its most solid parts melted down to a jelly, if naked acids were to be received into the general mass of fluids.

[m] *Ibid.* p. 148. acids are neutralized during the alimentary fermentation; and therefore they cannot act as acids, by saturating any thing of the alkaline kind that they meet with in their course of circulation.

expression)

expression) supra-saturated with the acid [n], which in putrid diseases cannot be the case. And farther, a heat of 212° of Fahrenheit never can increase the action of the acids in living bodies, as it did in the experiments; for, though Dr. M'Bride denies this consequence, and will prove the contrary, as the flesh with the alkali did not dissolve; yet this circumstance proves nothing more, than that the volatile alkali has not such power of dissolving the gluten of animal fibres, as acids have; for, if the effect depended only on the action of the acids by themselves, the flesh would rather have been dissolved when immersed in them, than when boiled in water.—The Doctor besides seems not quite consistent on this head; for, p. 151, he says, "Astringents can only be of importance in those cases, where, from extreme relaxation and resolution of the solids, the dissolved fluids are suffered to transude, and either form spots of different hues, or run off by actual hæmorrhage; here, indeed, the acid of vitriol, as an astringent, not as an acid, is found of great use in gaining time." As the acid could not exert its astringent power on the vessels, without coming to the *secundæ viæ* (p. 153.) he seems not afraid, in this case, of its melting down the most solid parts to a jelly.

In proof of his *third reason*, he alledges some experiments; viz. the third, p. 40, where a mixture of *flesh*, bread, lemon juice, and saliva, did not effervesce, after fermentation with an alkali; and the 5th,

[n] This has, it seems, happened in some rare cases quoted by Dr. M'Bride, and Dr. Haller, p. 148.

p. 42, where a mixture of bread, water, saliva, and spirit of vitriol effervesced smartly, before the intestine motion; but not at all after it. I could object against these experiments, and especially the 5th, that perhaps the proportion of the saliva to the acid was too great, and that a person in a putrid disease ought to take more acids than could be neutralized by the inquiline liquors. However, I will not insist on this; and suppose these experiments to be quite applicable to the case: but if these mixtures do not effervesce any more, does it follow, "that they are neutralized, and therefore act as acids, by saturating any thing of the alcalinous kind, that they meet with, in their course of circulation?" There are some saline bodies, which do not effervesce when mixed together; which will, however, change one another's nature. Thus *f. e.* brimstone, mixed with a strong fixed alkali, does not effervesce [e], but changes, on being dissolved, the nature of the alkali. A solution of soap does not effervesce on the addition of an acid, but joins with the acid, and neutralizes it. These instances made me suspect the conclusion drawn by Dr. McBride from his experiments; and to clear up these doubts, in this particular case, I referred to experiments. For this purpose, I mixed, the 4th of August, the thermometer being at 64°, three ounces of saliva, a dram of the liquor of

[e] This applies also to the solution of brimstone in limewater, out of which the lime particles have been precipitated, by the introduction of fixed air.

putrid flesh, and a very small quantity of bread : and added as much of the diluted spirit of vitriol, as to make it sour, and effervesce definitely with the alkali. There was not any sign of intestine motion till the 7th of August, when from time to time some air bubbles, and also some solid particles, rose to the top ; and this continued till the 8th. Not perceiving any farther motion, I poured off the clear liquor, which did not effervesce any more with the alkali. I mixed, the 9th, six drams of the putrid liquamen, with about the double of this liquor, and put in besides four solid pieces of flesh, which had lain three days in the liquamen : these pieces were of a prodigious stench, and so rotten, that with the least force they were torn to pieces. There appeared no signs of intestine motion : the 10th, the putrid smell was very much abated : the 11th, it was changed, and there remained only a smell much like that of sound flesh : the pieces were without any smell, and had acquired again some degree of firmness. In this condition they remained for a week, and I did not observe them any longer.

This experiment proves, I believe, that acids, though changed in the alimentary canal so far, as not to effervesce with alcalies, may notwithstanding check putrefaction ; and that, therefore, their use is of great consequence, and ought not to be omitted in putrid diseases. Though Dr. M'Bride believes that these diseases may be cured with fermentable substances only ; I must own that I do not agree with him, and am not quite convinced of his opi-

nion, that putrefaction depends only on the loss of fixed air. I rather believe this an effect than the cause of putrefaction ; but I shall refer this subject to another occasion.

END OF PART I.

I. A. B. L. 75.

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